Electrical World and Engineer

THE CONSOLIDATION OF "THE ELECTRICAL WORLD" AND "ELECTRICAL ENGINEER."

VOL. XLIV. NEW YORK, SATURDAY, DECEMBER 3, 1904. No. 23.

ELECTRICAL WORLD AND ENGINEER

Published weekly by the

McGRAW PUBLISHING CO.

114 LIBERTY STREET, NEW YORK.

TELEPHONE CALL: 7605 CORTLANDT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

EDITED BY T. C. MARTIN AND W. D. WEAVER.

CHICAGO OFFICE - - - - - - 1139 Monadnock Block.
PHILADELPHIA OFFICE - - - - - - 929 Chestnut Street.
ST. LOUIS HEADQUARTERS, Section 1, Electricity Building, Louisiana Purchase Exposition.
EUROPEAN OFFICE, Hastings House, Norfolk St., Strand, London, Eng.

NOTICE TO READERS

WHO ARE NOT SUBSCRIBERS.

ELECTRICAL WORLD AND ENGINEER is not returnable from the newsdealer. If you desire to purchase the paper from a dealer it will be to your advantage to notify him that you will want it, in order to insure his having a copy for you. If you wish to receive the paper regularly, please send in your subscription so that we can mail it to you direct.

Single copies are 10 cents each. The 52 copies for the entire year cost $3.00 in advance. Please send remittance with your subscription order.

ELECTRICAL WORLD AND ENGINEER.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of ELECTRICAL WORLD AND ENGINEER by 10 A. M. MONDAY of the week of issue. New advertisements can be received up to noon of Tuesday of the week of issue.

The first issue of each month is an export issue, having an extraordinarily large foreign circulation in addition to the regular domestic and foreign circulation of this paper.

TERMS OF SUBSCRIPTION.

United States, Canada or Mexico	Per year, $3.00
Foreign Countries, within the Postal Union	6.00
Great Britain and Ireland	25 shillings
Germany	25 marks
France	31 francs
Single copies	.10

Remittances for foreign subscriptions may be made through our European office.
In requesting your address changed give OLD as well as new address.

Copyright, 1904, by McGRAW PUBLISHING CO.

Entered as second-class mail matter at the New York Post Office.

NEW YORK, SATURDAY, DECEMBER 3, 1904.

CONTENTS.

Editorial 923
Supreme Court Action on Tesla Split-Phase Patents 926
November A. I. E. E. Meeting 926
The Combined Lighting and Heating Plant of the Columbus, Ohio, Public Service Company 927
Legal Damage Due to Lighting 929
Commutation in Alternating-Current Motors at Starting. By Marius Latour 930
Navy Wireless Telegraphy 932
Niagara Power in Buffalo—I 933
Electromagnetic Torque. By A. S. McAllister 936
On the Experimental Determination of the E.M.F. of Dispersion or Stray Field of an Armature Winding. By C. F. Guilbert 937
Rotary Engines. By Prof. Dr. F. Niethammer 939
The Evolution of High-Tension Insulators 940
A Review of Electricity at the St. Louis World's Fair. By Prof. Winder Elwell Goldsborough 943
Tesla on the New York Subway 945
Persuasion and Pressure in Telephone Development 945
New Telephone Patents 946
Interstate Independent Telephone Convention 947
Design for an Edison Medal 948
The Lackawanna and Electricity 948
Current News and Notes 948
LETTER TO THE EDITORS:
The Relative Reliability of Wireless and Wire Telegraph Systems. By Reginald A. Fessenden 949
Digest of Current Electrical Literature 950
The Electrolytic Meter. By R. S. White 954
More New Types of Prime Movers at the World's Fair 955
Harrisburg Works to Build Turbines 957
Motor-Equipped Pump-Building Shops 957
Special Applications of Electric Motors at the World's Fair. By Cloyd Marshall 959
Miscellaneous Exhibits in Electricity Building at St. Louis 962
Combination Switch and Plug Cutouts 963
The Silent Chain for Driving Machinery 964
Electrical Holiday Gifts 965
An Electrical "Wonderworld" for New York 965
Bogia Regulating Socket 966
A European Hydraulic Governor 966
Meeting of Westinghouse District Office Managers and Heads of Works Departments 967
Adjustable Lamp Hangers 968
Pumping Tar and Other Heavy Liquids 968
Apparatus for Thawing Pipes 969
New Motor Speed Controller 969
Commercial Cable Company's Plans 970
Single-Phase Railway at Indianapolis 971
Aaron Electric Motor 971
Tests of Allen-Bradley Controllers 971
Shultz Belting Exhibit 971
Miniature Electric Locomotive 971
News of the Week 972

THE ST. LOUIS EXPOSITION.

The St. Louis Exposition now passes into history, and the article that we print this week on its electrical aspects will serve as an admirable valedictory. On the whole, the management of the great show and the city of St. Louis are to be congratulated upon the success achieved. It is true that in many respects the thing was far too big and was overdone. In some respects it was very crude and provincial rather than international and cosmopolitan. Foreign visitors have been free in confessing their disappointment at the absence of elements that go to constitute the admirable smoothness and finish of exposition work in Europe. All of which being conceded, the fact remains that St. Louis gave a great exposition, and that its influence will be felt here at home in many departments of life, as well as universally in the progress of the arts and sciences. What it has meant to electricity is well set forth by Prof. Goldsborough, who in his own field did excellent work and has much to be proud of. The part of electricity at St. Louis was a large one, and if we should be unfortunate enough to have any more of these colossal fairs, its rôle will in them be even more important and conspicuous than it was as an item of the spectacle on the banks of the Mississippi in 1904.

So far as our own pages go, the Exposition has been carefully and fully treated. It has in fact received from week to week elaborate attention in a variety of articles, some by our staff on the ground at Electricity Building, and some by special contributors. Our present issue presents further descriptions and illustrations and in a manner "rounds up" the Fair, although doubtless other matters in connection therewith will arise for discussion. Not only have the exhibits been liberally portrayed, but the meetings and conventions have also been dealt with liberally as to space and editorial attention. The Electrical Congress may be cited as an instance. The week it was in session no fewer than 16 of these pages were devoted to a report of what was going on a thousand miles away, embracing terse abstracts of the great majority of the papers presented. Without the lavish use of the telegraph such a feat would have been impossible.

During the Exposition this journal extended the hospitalities of a handsome booth to many thousands and thousands of its readers and friends from this country and all over the world; and while it is satisfaction enough to know that the efforts of the staff were appreciated, it is also pleasant to record the award of a gold medal to this journal for its exhibit as a publication. Whether this means little or much, it will remain with a host of pleasant recollections a permanent souvenir of the great St. Louis Exposition, now a thing of the past.

THE WORLD AS A MARKET.

The continuance and emphasizing of precedent political conditions in the United States at the beginning of November has been followed by a marked improvement in business conditions, although throughout the summer there was a strong tone of confidence as to the future. Perhaps another great period of industrial expansion is at hand. Many signs point that way. But even if there be no boom, an undesirable thing at best, there certainly awaits this country another term of activity after the dullness of the past two years. The revival was not expected so soon. It is here, nevertheless, and all sails are being trimmed to the favorable breeze, now carrying trade and industry far away from the region of the doldrums.

What is best is that other countries besides our own are feeling the inspiration of better times, notably our close friends and great customers, Germany and England. In both countries, which have been sorely tried since 1900, the note of cheerfulness is heard; and no good reason can be found why they should not enjoy a new era of prosperity. Incidentally it may be noted that that great fructifying agency, the gold from South Africa, is again returning to its high level of output reached before the Boer war. All the countries of Europe felt that stimulus, and the united trade of eighteen of them now amounts to $8,000,000,000 in imports and $6,000,000,000 in exports. The wealth and population of Europe are still growing, and we in America shall certainly share in both, even if this country were not doing a little on its own account, in both respects.

Peace has its demands on industry as well as war, but the destructive effect of war does most undoubtedly, if only for a time, stimulate reproductive processes. Our own columns record this week the tremendous export demand as to mechanical apparatus coming just now from Japan. Part of this is due probably to the repair of waste; part is probably for the work on the new navy that Japan is determined to have. Russia also must and will renew her armament progressively, and between the two the call for supplies from this country already promises to be enormous. It is also not to be gainsaid that when this sad and bloody Eastern war is over, that part of the world will be open also to American commercial conquest as never before. If it were not, this country, too, would be in the fray. America is not staying out of the game with any intention of having bars put up or doors slammed in her face when it is over.

Recent figures as to manufacturing exports are most encouraging. October's exports of that class were $47,355,678, or ten millions more than in 1903; while for the ten months they were $412,946,036, as compared with $348,688,560. This is a most material gain and it is evidently well sustained. Now that the home trade is lively again, it behooves American manufacturers to remember how vital and necessary the foreign market is to them, and neither to neglect present grip on it nor to forget the importance of its further cultivation by all the arts and means in their power.

INSULATOR DESIGN.

Mr. Converse's congress paper on the evolution of the high-tension insulator puts in clear form the requirements which practice has shown to be necessary in making insulators for the pressures now in use. After many struggles it now seems that suitable insulators are available for pressures certainly up to 40,000 volts and perhaps 10,000 or 15,000 volts beyond. The first and most obvious difficulty in insulators for high voltage was the danger of leakage over the surface. It has not been at any time difficult to get insulators that will not actually puncture, provided one did not insist on using poor material. The first effort to increase the protection against leakage was the addition of an oil groove, as in the Frankfort-Lauffen experiment and elsewhere. Good enough in theory, it was soon found that the oil could not be kept clean and after some time became worse than useless. Cut off from using oil, the obvious step was to increase the distance over which leakage would have to take place by increasing the number and size of the petticoats. The first result of the policy was poor insulators, owing to the difficulties of making the bulky and complicated forms. Porcelain is useless unless it is dense and well vitrified, and glass in large and complicated forms is hard to surface and anneal in manufacture. The next step was the composite insulator of which the separate parts were of shapes and sizes feasible to manufacture in good quality. It is quite certain that for modern high voltages this composite structure is necessary and can be made sufficient. As voltages have risen the question of leakage has grown more and more serious. The striking distance of 50,000 volts or so over wet or dusty surfaces is large. To gain in protection against this increase of striking range two modifications have been made in the insulator forms.

In one of these the underlying principle is that leakage is likely to follow the surface, especially if it is wet or dusty, and the result is an insulator with relatively small diameter and rather deep and nearly vertical petticoats. Another form is derived from the idea that the discharge when an insulator "spills" over is from petticoat to petticoat across the air and not along the surfaces, and hence at least the upper petticoat is made flaring and of rather large diameter. Now at very high pressures an insulator does "spill over" in precisely this way and in so far the "mushroom" type of insulator is justified. But it is also true that in bad weather, when the surfaces are thoroughly wet, discharges over the surface are particularly likely to lead to spilling over, so that it does not do to shape the petticoats so that the interiors are freely exposed to the elements. Hence, modern insulators tend, as Mr. Converse shows in his illustrations, to forms which give a sufficient distance between the edges of petticoats without freely exposing the interiors. These forms have shown themselves capable of excellent results at the highest pressures now regularly in use, without going to forbidding dimensions. Danger of actual puncture save from flaws in the material is rather small, but if the material be porcelain in which flaws are not readily seen, wholesale testing under a high voltage is a necessity. Glass seems to be generally regarded as rather less desirable than porcelain, owing to less mechanical strength and less permanent surface, although it is successfully used in some high-voltage transmissions. It would seem to be worth while for some one to experiment on special glasses for insulators. In the famous Jena glass works they seem to be able to turn out glasses of special properties with considerable facility, and it certainly would be worth while to try for a glass of extra high strength and of surface capable of withstanding the weather. Such a glass would be more desirable than porcelain on account of the visibility of faults, and would save a rather troublesome test.

Experiments on improved insulator materials are necessary if the present limit of high pressure is to be pushed upward, as it sooner or later must be. Quality rather than quantity is desirable in insulators. The tendency toward long spans makes mechanical strength of particular importance, and every increase in size makes the adequate support of insulators more troublesome. If wooden pins continue in use for high voltages, the mechanical strains must be kept down; and if steel pins are used, the potential gradient through the insulator rises and demands increased dielectric strength. Under some climatic conditions another condition must be imposed on the insulator design, namely, that it must be such as to permit of easy cleaning. A very moderate amount of well-distributed dirt will put any insulator out of service. With respect to cleaning a very smooth surface is desirable, and this may ultimately be found in glass rather than in porcelain. This question of dirt is certainly one which frequently comes up, although it is not always recognized. There has been great diversity of experience with certain types of insulators, and if the whole truth were known it would probably appear that dirt was at the bottom of the difference. And in line design provision should assuredly be made for fairly easy access of the insulators for cleaning. Fortunately, practice is drifting away from the old plan of many circuits on one pole line, owing to increased voltage. Permanence of surface is really more important as regards dirt catching than with respect to carrying moisture, since incipient leakage on a high-voltage insulator tends to dispel moisture.

One very important matter on which we wish Mr. Converse had laid stress is the requisite factor of safety in the insulators. It generally is, we fear, the lowest on the system, not from choice but from necessity. A factor of safety of 2, for example, leaves no great margin for contingencies, and yet this factor is perhaps rather larger than the average in the ordinary high-voltage plant. Considering the fact that line insulation is the weaker spot in long-distance power transmission, it would be worth while to concentrate attention on the insulators as the special problem of the immediate future.

THE EXPERIMENTAL DETERMINATION OF THE REACTIVE E. M. F. OF AN ALTERNATOR ARMATURE.

On page 937 we print an article by Prof. Guilbert on the predetermination of alternator characteristics. His method applies particularly to a revolving-field alternator, in which the armature is the external stator and the revolving field the internal rotor. The method consists in employing two stationary test coils in series, one closely associated with the turns of any single armature coil and the other applied flat over the same in the entrefer, but held clear of the revolving-field poles. It is shown that under defined conditions the e.m.f. induced in these two test coils measures the reactive e.m.f, or stray flux, of the armature. The formula for this induced e.m.f. agrees with one already published by E. Arnold, as representing the e.m.f. of dispersion. It is not always easy to wind a test coil of even fine wire up with an armature coil; but when this can be done without inconvenience, the method is well worthy of being experimented upon.

THE ELECTRONIC THEORY OF METALLIC CONDUCTION.

The electronic theory is now in fashion, and we must expect to have our views of natural phenomena electronized, just as literature, art and manners follow prevailing modes. Whether we shall go too far in these electronic hypotheses, the future will no doubt determine; but, for the present, we can enjoy electrons and be content. According to the electronic view of conduction in liquids, without electrons there would be no conduction. In chemically pure water, for example, the electronists tell us that the bond of union between hydrogen and oxygen is so tight that all the atoms or particles of the water are locked up in their respective molecules, and there are no detached or semi-detached pieces to serve as electrons and carry an electric current. Vainly will a potential difference between a pair of immersed opposing metal plates stretch across the water and strive to transport electricity. The water atoms grip each other tightly and refuse to be beguiled into acting as porters. When, however, a little sulphuric acid or any electrolytic material is poured into the water, thereby rendering the latter impure, it is asserted that the molecules of the acid break up into ions or electrified components, which go swimming about idly in an aimless sort of way among the rigid water molecules. Under these conditions a potential difference established across, or through, the mass of solution will set up organized processions of electrons, the positive electrons being attracted toward the negative electrode and the negative electrons toward the positive electrode. The rate of the march is quite slow, from the standard of a military march; but the crowd of electrons is multitudinous, and as each electron reaches his goal or opposing electrode he discharges into it his electronic charge, even as the laden bee throws down his burden of honey on reaching the hive. Accordingly, the total quantity of electricity discharged at the electrodes per unit of time makes the steady current observed in the circuit.

As for gases, the electronists say that ordinary gases contain in the normal condition but few electrons. When, however, a considerable potential difference is brought to bear upon a stratum of gas, such as air, between two metallic plates or electrodes, the electrons that are present fly much faster in their procession than they can in liquids, and hurl themselves in collision with the idle gas molecules that happen to obstruct their paths. When the potential difference is sufficiently powerful the velocity of the advancing electrons becomes so great that in their collisions they shatter the molecules on which they impinge, and knock chips off them, as a flying pebble will knock splinters from the stone it strikes in falling. These chips or splinters are, it is said, always electrons; or, to express the idea in a different way, any molecule is built up in a certain structure of which the individual elements are electrons. Consequently, when an element is knocked out of a molecule by the blow of an impinging electron, rushing in the procession across the electric field, the element knocked out is naturally another electron. Above a certain critical voltage, therefore, for any given gas at a definite temperature and pressure, there will be a very rapid multiplication of electrons entering the processions and the discharge will be relatively powerful, taking the form we call the arc discharge.

Following the theories very crudely indicated above, the phenomena of electric conduction in liquids and gases is satisfactorily explained in a number of particulars. In regard to conduction in metals—in copper wires, for example—the electronic theory seems at first sight to lend itself less readily to aiding conceptions. There is ample room for electrons to fly, like meteors, in a vacuum tube. There is no doubt plenty of room for electrons to make much more limited flights in gases under pressure, such as in ordinary air. There is, no doubt, room for electrons to jostle each other comfortably and to rub elbows in their slow processions through liquids. But in a wire of solid copper is it possible that conduction depends upon the movement of material particles? The electronic theory of conduction in metals has, however, already received considerable attention and development. A splendid paper on the subject was presented to Section A of the International Electrical Congress of St. Louis by Prof. Drude, who has done much to advocate and introduce the theory. According to this paper there are electrons present in metals. There are plenty. In a cubic centimeter of copper at ordinary temperatures the number of electrons is expressed by the numeral 4, followed by twenty-two zeros. There is about one electron to every two atoms of copper. When a difference of potential is brought to bear upon a mass of copper, for example, a copper wire, these enormous numbers of electrons, each naturally holding its inherent electric charge, moves forward along the lines of electric stress in an endeavor to form a procession. The procession cannot actually form, because the molecules block the way, but the electrons collide with their nearest molecules in the assigned direction and hand over electric charges somehow. The mean path over which they carry this charge from one molecule to the next is given as about a microcentimeter, a minute distance that is, however, large compared with the size of an electron itself.

According to this view, conduction in metals differs, perhaps, from conduction in gases in the fact that in liquids electrons meander long distances, and eventually reach the electrodes, whereas in metals they only oscillate and form a bucket brigade, passing the electricity along by successive stages. Whether the transfer in metals is by bucket brigade or by procession, Prof. Drude's paper shows that many phenomena may be satisfactorily explained by the electronic theory of metallic conduction. Thus, the proportionality between electrical and thermal conductivities, the variation of conductivity with temperature, the thermo-electric force, the Peltier and Thomson effects, are all more or less accounted for by this hypothesis. If Prof. Drude's theory is reliable, we may generalize all the phenomena of conduction in solids, liquids or gases, and say that electricity cannot be steadily conveyed through space anywhere except by carriage on the backs of electrons.

Supreme Court Action on Tesla Split-Phase Patents.

On Monday, November 28, the United States Supreme Court denied a petition for a writ of certiorari directing the United States Court of Appeals for the First Circuit to certify a case tried by that court for review by the Supreme Court. The petitioner was the Stanley Instrument Company and the respondent the Westinghouse Electric & Manufacturing Company.

The patents in suit were the Tesla patents, Nos. 511,559 and 511,560, granted December 26, 1893, and commonly known as the Tesla split-phase patents. The first stage of the litigation ended March 11, 1903, when Judge Colt, of the Massachusetts Circuit Court, declared the patents invalid owing to a publication in an Italian journal dated April 22, 1888, of a lecture by Ferraris. The case was then carried to the Circuit Court of Appeals and on September 9, 1904, that court decided that sufficient proof had been presented to show that Tesla had made the invention involved prior to the date of the Ferraris publication.

The principal contention for a review of the case by the Supreme Court was that the Circuit Court of Appeals for the Second Circuit had decided in an opinion dated February 25, 1903, that the said patents were invalid on the grounds of the Ferraris anticipation, and that the decisions of the Courts of Appeal of the First and Second Districts were at variance and conflict with each other, and that the error of one or the other could only be authoritatively corrected by the Supreme Court. The respondents in answer to this contention held that the alleged divergence between the courts relates only to the sufficiency of the Tesla proofs as contained in the two records, on a question of fact; that the two courts had before them substantially different records, and therefore there was no "conflict" and the case consequently was not appropriate for certiorari.

November A. I. E. E. Meeting.

At the November meeting of the American Institute of Electrical Engineers, held at Carnegie Hall, November 25, Secretary Pope announced the election of 53 associates and the transfer to full membership of five associates. The paper of the evening was entitled "Problems of Heavy Electric Traction," the authors being Messrs. O. S. Lyford and W. N. Smith. The paper was read by Mr. Lyford.

The paper gives in detail an account of some of the engineering studies made in connection with the work of applying electric traction to the Long Island Railroad system. This work is now in progress and the plans provide for the immediate adoption of electric traction on the lines emanating from Flatbush Avenue and for a progressive extension of electric traction over all the strictly suburban routes as rapidly as the conditions will justify. For the convenience of suburban residents, a frequent service in comparatively short trains is to be provided for, but for the excursion service the number of cars per train will vary from eight to possibly ten. The service calls for 52 types of trains, and the paper gives the various considerations which enter into the solution of the questions which this condition presented. The largest motor in general use for motor car trains is of 200 hp nominal rating, two of these being on a car. The motor cars are to be of steel, and weighing with a seated load 81,000 pounds, the trailers weighing 60,400 pounds.

The greater part of the paper relates to speed time tests. The subject is considered under the heads of plotted and test runs compared; application of formulas; use of typical run curves; schedule speed requirements and limitations. The various formulas that have been offered for the determination of train resistance are discussed and a new one is offered called the Smith formula, which is stated to give results closer to actual practice than other formulas that have been proposed. This formula has the expression $R = 3 + 1.67\ V + .0025\ A/T\ V^2$, R being the train resistance, V the speed in miles per hour and A the cross-section of the car in square feet. The paper proceeds to make comparisons of the results given by the calculation of schedule speeds and those obtained in actual tests, many curve sheets being given.

The discussion of the paper was one of the most interesting that has occurred at Institute meetings for a long while. It was participated in by Messrs. Stillwell, Mailloux, Ward Leonard, W. N. Smith, A. H. Armstrong, E. E. Reis, O. S. Lyford, N. W. Storer, Dr. Hutchinson and Prof. W. S. Franklin. Mr. Stillwell said that the engineers of the Interborough Company have used a velocity curve suggested by Mr. H. N. Latey, based upon the formulas of the Baldwin Locomotive Works, Davis, Wellington and Lundie, and more particularly on the results of numerous tests made by Mr. Stillwell and some of his assistants at various times during recent years. The algebraic expression of this formula has not, however, been derived. The fact that the Baldwin formula gives for all speeds much lower than those derived by using the Davis formula, is probably accounted for by the fact that the former is based upon tests of trail cars only.

Mr. C. O. Mailloux expressed himself as skeptical concerning the value of empirical formulas for calculating train resistance. Such formulas ignore starting friction and their discrepancies at relatively low speeds are partly due to the existence of starting friction He himself had devised an empirical formula which gives results agreeing very closely with tests, but he had not taken it seriously. He considered that with the use of hypothetical curves results may be obtained close enough for first approximations, except in unusual cases.

Mr. Ward Leonard in his remarks gave some interesting statistics concerning steam railroads. The steam railroads of the United States as a whole have about 125 hp per mile of line. Referring to specific railroads, this figure for the Pennsylvania Railroad is somewhere in the neighborhood of 550 hp per mile of line, and on the Pittsburg & Lake Erie ore-carrying roads, it reaches as high as 1,000 hp per mile. The steam locomotive of the latest type and largest power will cost, including tender, about 5 cents per pound, but the useful weight or that upon the driver costs 9 cents per pound. Since electric locomotives have all their weight on the drivers, he believes that they can easily be manufactured in high powers for the latter figure. In the case of roads employing 250 hp per mile of line, electric locomotives can replace steam locomotives with a very decided economy, and the cost of equipping a steam railway of that character with all generating distributing apparatus in electric locomotives would not be far from 15 per cent. of the existing capital of the road. He pointed out that the cost of maintenance of steam locomotives is as much as the cost for fuel per mile, statistics showing this at $3,500 in each case. As to the weight of the Ward Leonard electric locomotive, that being tested in Switzerland has 125 pounds per hp on the drivers, and the latest types of powerful steam locomotives have 117 pounds per hp on the drivers. It may become necessary to increase the weight of locomotives beyond 120 pounds per hp, and if the weight is not in machinery it will have to be added as dead weight. Mr. Leonard gave as a short cut for calculating the horse-power at the drawbar as follows: Multiply the miles per hour at which the train is moving by the pull in pounds at the drawbar; doubling this product will give the watts. For example, in the case of a locomotive with 30,000 pounds drawbar pull running at 20 miles per hour we get 1,200 kw, or 1,600 hp. He pointed out the great advantage of the electric locomotive in its overload capacity for use on grades. The electric locomotive for a considerable distance may be run at three or four times normal horse-power, while a steam locomotive is limited to twice normal power. He considered the saving of fuel in electric traction as trivial.

Prof. Franklin said that there is no theoretical relationship between friction and speed, and consequently there can be no ultimate theoretical solution of the problem involving these factors. The most important results from tests would be the establishment of the variation of friction at different runs, so that the designer of car equipments may make provision for the unavoidable discrepancy between the calculated amount of power consumed and the actual amount for runs.

Mr. N. W. Storer, in a communication, said that after all is said and done the selection of a proper sized motor quickly narrows itself down to a choice between two sizes of commercial motors, and after that it is a question of the selection of the right gear reduction. His experience is that the Davis formula shows excessive train resistance at high speeds and he mentioned a formula suggested by Mr. Blood which has shown itself to be very close to the actual conditions. The single-phase system, he stated, possesses a marked advantage for making up lost time, since the type of control best adapted to this system is that of voltage control, which enables any voltage within practical limits to be applied to the motor. It is practically independent of the voltage on the line and in this respect is even more flexible than the steam locomotive.

The Combined Lighting and Heating Plant of the Columbus, Ohio, Public Service Company.

THE rapid growth of central station heating by means of hot water, especially in the Middle West, has created considerable interest among central station men, and the supply of this class of auxiliary service from electric generating plants has been the subject of considerable discussion in the last three years. A description of the recently installed plant of the Columbus Public Service Company, at Columbus, Ohio, will no doubt be interesting to many of our readers.

The main generating plant of the company is situated at Seventeenth and Mound Streets, three blocks distant from the heart of the best residential section and 1½ miles from the condensed business district. The building exterior is of impervious red pressed brick, the engine room being faced with buff brick with a seven-foot wainscotting of white enamel. Provision is made for an engine room crane, and both engine and boiler rooms are surmounted by monitors. All floors are of cement, the engine room floor being of reinforced concrete construction and affording a nine-foot basement. All foundations for machinery, boilers and stack are of vulcanite portland cement concrete. A general view of engine room is shown in Fig. 1.

The generators are of the revolving field type, wound for three-phase, four-wire system, 60 cycles, the voltage between phases being 4,000, with 3,000 volts between each phase and the neutral of the star connection, which is grounded throughout the system. The generators, which were built by the Bullock Company, have a normal rated output at 95 per cent. power factor and 35° C. rise, of 200 kw and 500 kw, respectively, the smaller unit being in the foreground. Both machines operate at 100 r.p.m. and have 72 poles. Space is provided for an additional unit. The generators are driven by heavy-duty, cross-compound, Cooper-Corliss engines, which are at present operated non-condensing, with provisions for future condensing operation during warm weather when the heating system is not in use.

The larger engine is 22 in. x 40 in. x 42 in., with a 16-ft., 25-ton wheel, and the smaller unit is 14 in. x 26 in. x 36 in., with a 14-ft., 13-ton wheel. The shafts are 18 in. and 13 in., respectively, with main bearings 16 in. x 32 in. and 10 in. x 18 in. Main bearings are adjustable vertically as well as sidewise and bottom shells are water-jacketed for emergencies and are removable by lifting shaft 3/16 in. Both high and low-pressure sides of each engine have continuous oil channels around bases and sole plates and the cylinders are fitted with extension sole plates, which enclose the dash pots. The valves are multiported and the exhaust and admission valves are operated by independent eccentrics. Engine governors are provided with automatic safety stops and are adjustable, while in operation, for dividing the load between generators. The piston rods and valve stems have metallic packing, as the steam is superheated from 60° to 110° F., and separators are dispensed with. All bearings are arranged for either cup or pressure oil feed with piping of nickeled brass. The drip oil is caught by covered trays and led to the basement, where it is filtered and pumped to an elevated tank. The eccentric and crank oil guards are of polished steel joined by brass angles.

The exciters, which are partly shown to the right in Fig. 1, are two 50-kw General Electric units, one of which is directly connected to a simple American Ball engine using saturated steam through a reducing valve at 100 pounds pressure. The other unit is directly driven by a 75-hp, 4,000-volt, three-phase General Electric induction motor with flexible coupling.

The switchboard, which was built by the Westinghouse Electric & Manufacturing Company, is shown in Fig. 2. Beginning at the left, the first and third panels control the alternating-current generators, and the second and fourth control the field circuits of the main generators. The sixth and seventh panels control the exciter units, while the fifth panel is left blank for a future exciter unit. The eighth panel controls the motor driving one of the exciter units. The ninth or load panel is equipped with recording and indicating wattmeters, frequency and power factor meters, ground detectors and four total ammeters. The tenth panel is blank and the next two are for lighting feeders. Each lighting feeder panel controls three single-phase feeders by means of oil switches, compensated voltmeters and induction regulators, which will raise or lower any phase 10 per cent. The thirteenth panel, not shown, controls two three-phase power feeders. At the extreme left of the board two long-range voltmeters and two synchroscopes are mounted on a swinging panel. The board stands 6 ft. from the wall and a concrete pit 4 ft. deep, covered by sectional gratings, extends the full length of the board at the rear.

The feeder circuits are run with lead-covered cable through 36 vitrified conduits to a large sidewalk manhole, whence they are led in metal conduits up the two 65-ft. station poles to points near cross arms. The generators and exciter circuits are run with lead cable in vitrified conduits, the runs to each switchboard panel being laid

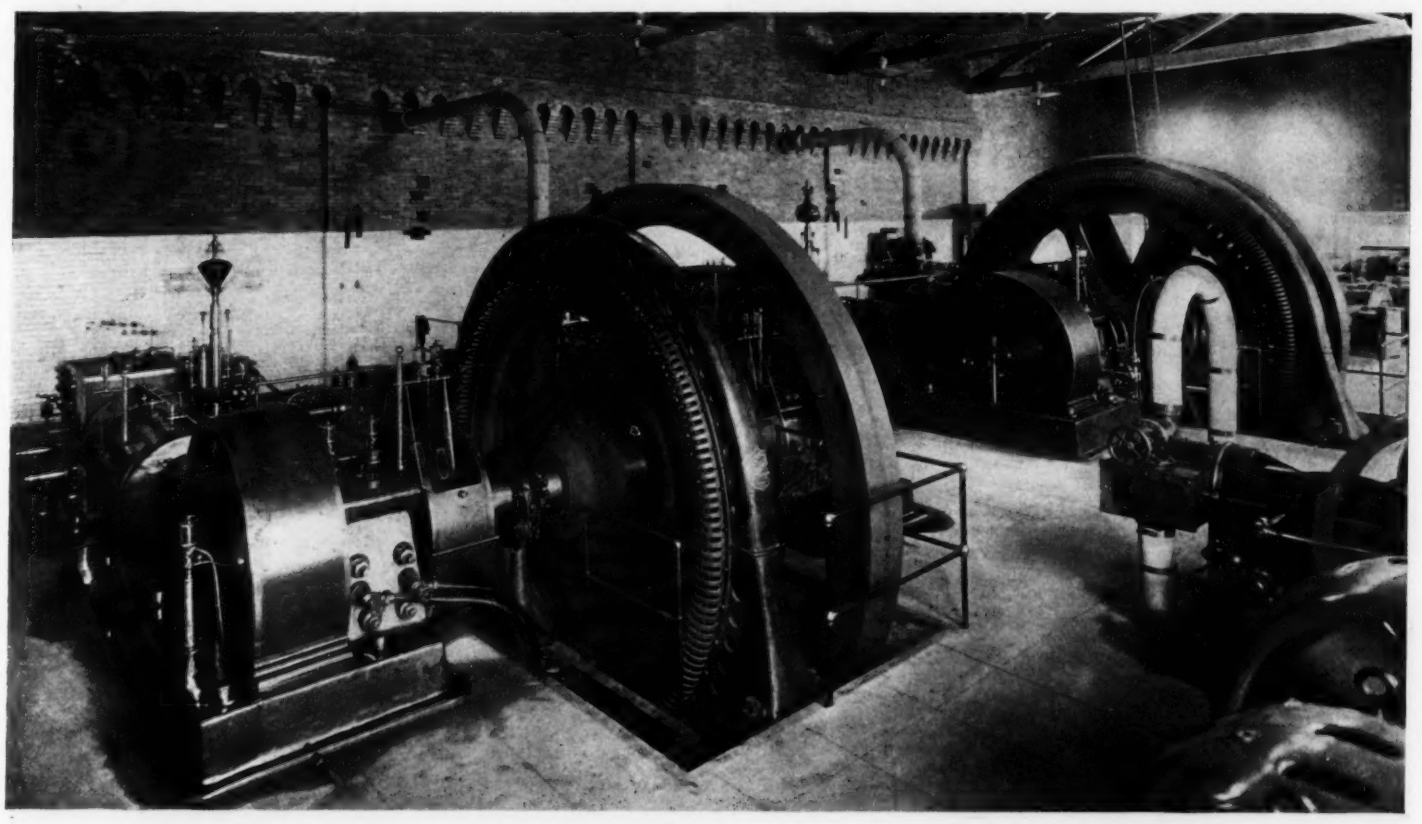


FIG. 1.—GENERAL VIEW OF INTERIOR OF COLUMBUS PUBLIC SERVICE COMPANY'S STATION.

in rotation, avoiding all crossing or running of these cables in the pit at the rear. The station conduits are set in concrete and form the foundation for the switchboard. A single cable is run in each duct. All lighting wiring in the plant is run in iron conduit. The arcs are operated from the alternating generators and the incandescent lights from the exciters.

The lighting, in the business district and as far as possible in residential territory, is supplied by three-wire secondary mains. The stationary motor load is carried on independent alternating-current

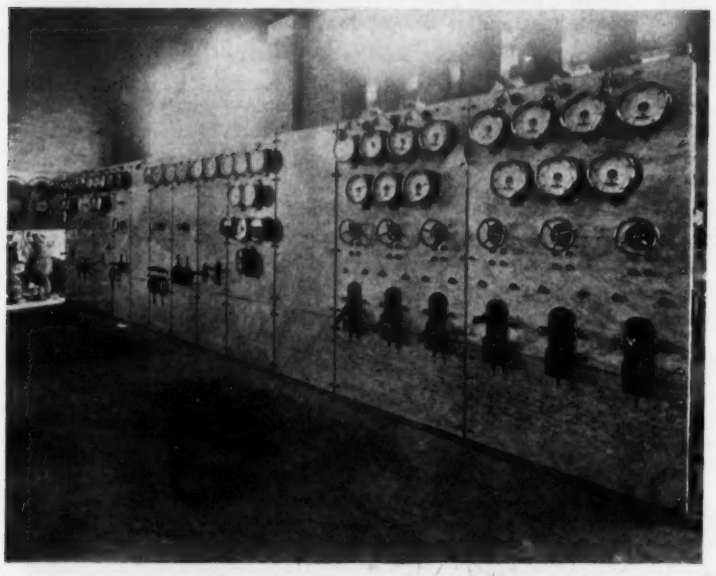


FIG. 2.—SWITCHBOARD.

feeders from the station. The direct-current elevator motors are supplied through two 100-kw, 250-volt rotaries, operating in a substation located in the heart of the business district.

The steam plant consists of three 350-hp, double-deck, vertical header Babcock & Wilcox boilers, built for 160 pounds working pressure, and equipped with Babcock & Wilcox chain grate stokers and superheaters. The boiler settings have a 13-in. inner wall and a 9-in. outer wall, with a 2-in. air space between, the two walls being tied together by corrugated metal ties to allow for differences in expansion. The boilers are, of course, suspended free from the brickwork. The inner walls are faced in all passes with firebrick, and the steam drums are covered with 85 per cent. magnesia 4½ in. thick. The rear drum heads are blank, as they will not be accessible when economizers are installed. The suspension frame is ready for the fourth boiler and foundations are in for an additional battery. The described type of setting has proven very effective as no sign of a crack has shown during the eight months of operation, and the bare hand can be held, without discomfort, on the outer wall opposite the stoker fire when the boiler is in operation. The side walls are faced with red pressed brick and the fronts with white enamel.

The flue gases are led to the stack through a brick flue, built at the floor level, which is equipped with main and by-pass damper frames for the future installation of the economizers, which will be placed above the smoke flue. The Custodis radial brick stack is 12 ft. internal diameter at the base and 8 ft. 6 in. at the top. The total height is 225 ft. above the foundation, which is 40 ft. square and 8 ft. deep. The stack has a Bajohr lightning rod of ⅝-in. copper cable.

Coal is wheeled for the present over an inclined runway to the stoker hoppers, but provisions have been made to install a fuel storage with conveyors and crushers, to handle the coal from the cars or from any part of the storage through or around crushers to the overhead stoker hoppers carrying about 18 hours' supply for a battery. Provisions have also been made for a switch from the interurban railroad passing the plant, from which coal cars can be switched between 9 p.m. and 6 a.m.

The piping over the boilers is shown in Fig. 3. All high-pressure piping of 6 in. and larger is of open-hearth flanging steel and joined with loose, weldless steel flanges, using the recessed lap joint with copper gaskets. Lines of 5 in. and smaller are of standard extra heavy pipe, with threaded flanges on 3-in. and smaller. The water lines are of genuine wrought iron with cast-iron flanges, and the high-pressure lines are of extra heavy pipe. The boiler feed lines are of extra heavy brass pipe and fittings. Suction and exhaust piping is of full weight iron pipe. Long radius bends are used wherever possible, and all high-pressure valves, not used for throttles, are Chapman extra heavy gates, 4 in. and larger having outside screw and yoke. All high-pressure piping was tested at 400 pounds pressure, suction and exhaust lines smaller than 10 in. at 175 pounds, and 10 in. to 24 in. at 125 pounds. Superheated steam is used in main engines only. The 14-in. main header is run along the boiler side of the partition wall and the engine taps are made through angle gate valves. The lead from each boiler rises vertically about 6 ft. and is surmounted by an automatic check and stop valve, whence connection is made to the header by two long sweep bends with a gate between. The saturated steam outlets of boilers are connected to two headers, one for supplying the auxiliaries and the other for connection to the heating system. The feed water lines are in duplicate and the boilers may also be fed through the blow-off. High-pressure drains are returned direct to the boilers by automatic receivers. The blow-off main is carried to a 6-ft. x 8-ft. cast-iron drum with a manhole and a 4-in. vent to the roof and a 6-in. overflow to the sewer. There is practically no buried

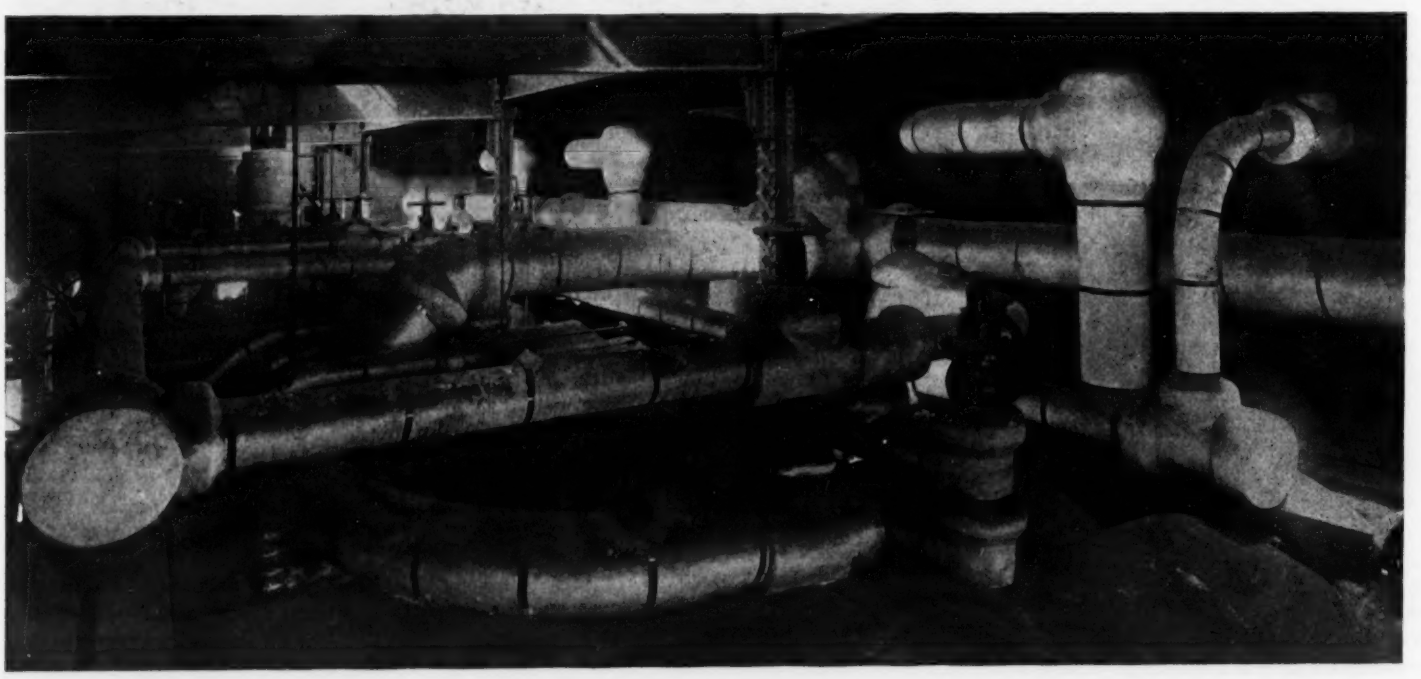


FIG. 3.—PIPING OVER THE BOILERS.

piping in the plant, except the heating system return line and the sewers. Compressed air is piped to the rear of the switchboard and to each engine for cleaning purposes. The power plant piping was installed by W. K. Mitchell & Co. and all hot piping is covered with Keasbey & Mattison 85 per cent. magnesia, the covering on the superheated steam lines being 3½ in. thick.

The station equipment for the hot water heating system is shown on Fig. 4. The return water from the system enters the suctions of the circulating pumps and is forced through the overhead heaters and thence again to the system. Provisions have been made for passing all or any portion of the water through economizers or through two of the boilers. The heaters are of Yaryan design, containing about 500 sq. ft. heating surface each, and are practically surface condensers except that the exhaust steam flows through the tubes, and the water to be heated surrounds the tubes, which are ½ in. in size and about 500 in number. Six heaters are in place and six additional are provided for. The heaters are operated ordinarily by exhaust steam, but live steam can be introduced, during light loads or severe weather, to three of the heaters. Each connection from the exhaust header to the heater is equipped with an oil separator. The condensation from heaters is returned to the boilers by automatic receivers. The station piping is so arranged that the heaters can be used for surface condensers for the main engines, and the exhaust from all auxiliaries can be discharged directly to the feed water heater or to the exhaust main. The circulating pumps can be operated on a cooling tower and through the condensers. An expansion tank 6 ft. x 18 ft. is connected to the heating system return. The 24-in. exhaust line from the engine room basement rises through the boiler room floor near the center of Fig. 4 and with branches 20 in. to the feed water heater and 20 in. up to the heaters or condensers, above which a back pressure valve is placed. The Cochrane feed water heater is supplied with the Sorge system of chemical treatment, and space and blank connections are provided

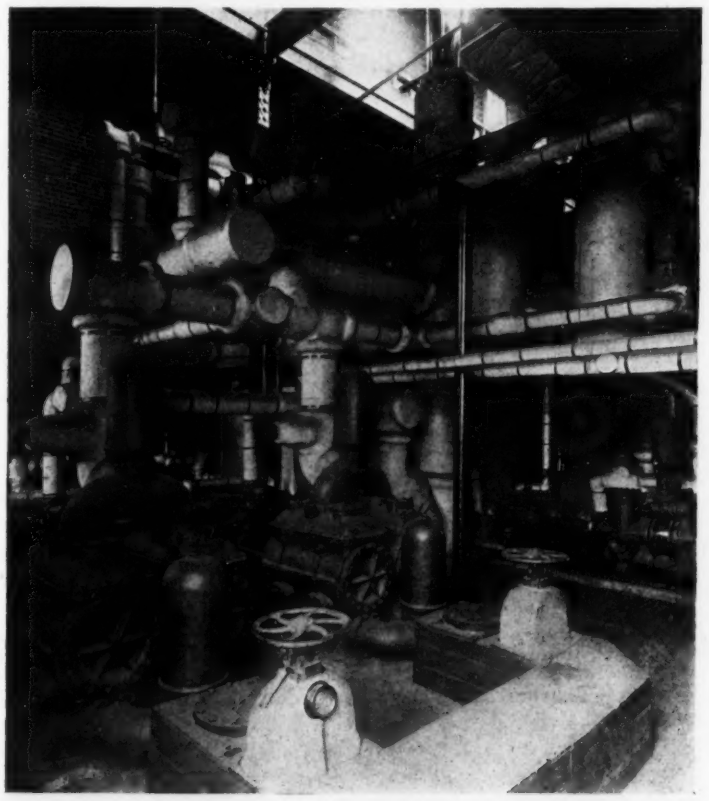


FIG. 4.—HOT WATER HEATING EQUIPMENT.

for a duplicate heater. The circulating pumps are duplex, tandem-compound, piston-pattern, 14-in. x 20-in. x 15-in. x 18-in. and the boiler feeders are extra heavy, single, outside center packed, plunger pumps 12-in. x 9-in. x 18-in., all of L. D. G. make.

The hot water distributing system covers the best residential territory of the eastern part of the city and most of the mains are laid in alleys. The two-pipe system is used with thermostatic regulation of customers' services, operated by a galvanized-iron compressed-air line run in the same trench with the heating mains and supplied by two Westinghouse compressors at the plant. The discharge and return pipes of the heating mains are laid in the same conduit, built of cypress wood, shown in Fig. 5. It is underlaid in clay or compact earth, with porous drain tile laid in a coarse gravel bed, for drainage. The insulating conduit is overlaid with asbestos asphaltum paper and the spaces around the pipe are filled in with shavings treated with crude oil.

The distributing system consists of about 6,000 ft. of 12-in., 1,800 ft. of 8-in., 1,500 ft. of 6-in., 7,000 ft. of 5-in., 14,000 ft. of 4-in. and

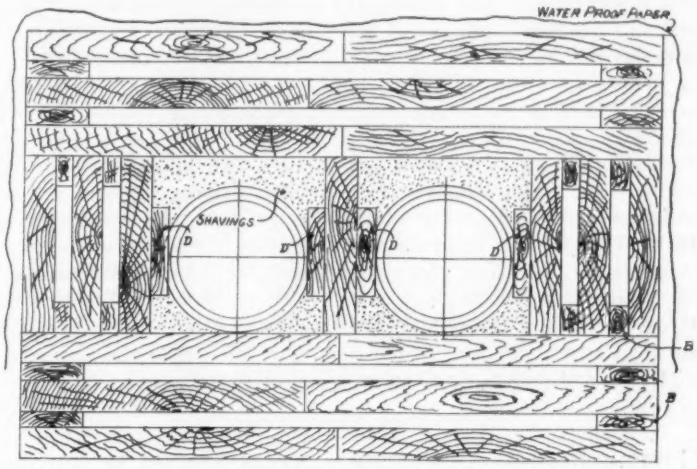


FIG. 5.—INSULATING CONDUIT FOR HEATING MAINS.

7,500 ft. of 3-in. Byers wrought-iron pipe. The system has an ultimate capacity of nearly 300,000 sq. ft. of radiation and has about 60,000 sq. ft. connected at present. Expansion and contraction are provided for by flanged, packed, slip joints of bronze on 6-in. pipe and larger sizes, and U-bends are used on smaller sizes. Anchors are placed midway between the expansion joints, which are spaced about 400 ft. apart. Flanged valves are placed on lateral runs and all valves and expansion joints are placed in brick manholes. Service taps on mains of 4 in. and smaller are made by means of cast-iron tees and on larger sizes are tapped directly into pipe. The greater part of the service is ¾ in., 1 in. and 1¼ in. in size. The heating business of the company has had a very rapid growth, notwithstanding the competition of natural gas at 25 cents per thousand.

The plant was designed with a view of doubling its present capacity and also of introducing refinements such as economizers, condensers, coal and ash conveyors, crane, etc., without alterations to the existing plant. The complete electric generating and heating plant was designed by and installed under the direction of Mr. Fred W. C. Bailey, the local consulting engineer.

Legal Damage Due to Lightning.

Note is made by the *Monthly Weather Review* of the United States Government of an interesting trial at Dijon, France. In this case the court held that half the damage litigated over was due to lightning and the other half to the violence of the wind; and further that one-half should be borne by the insurance companies. The parties in interest then came together and adjusted the matter. Some years ago a United States Circuit Court of Appeals held that forecasts of local rain have not yet attained such commanding respect by reason of their accuracy as to justify the holding of shippers guilty of culpable negligence if they do not provide against damage against heavy rains when light local showers are predicted. "The case of local rains is different from that of storms of great violence, whose existence, course and time of arrival are publicly announced by signals which the master of a vessel is bound to observe."

With regard to the case on trial before the court at Dijon, the record shows that on June 30, 1901, at about 6 p.m., after a day of exceptional thunderstorms, an extremely violent wind occurred, producing great destruction. Besides the destruction due to the wind, many cases were found in which the damage was undoubtedly due to lightning. Public opinion and the local press attributed everything to the passage of a tornado. The work of destruction was accomplished in a few moments, and was followed by a heavy fall of hail over a large area, after which occurred an exceptionally heavy rain. The administration of the docks of Burgogne attributed

a certain damage to lightning and demanded that the repairs should be made by the nine companies in which they were insured; but, on the contrary, the insurance companies maintained that the disaster was equally attributable to the wind, and that, according to their policies, they did not insure in any manner against damage done by "hurricanes or cyclones, tornadoes or any other meteorological or electrical phenomenon, except thunder and lightning."

In the trial before the judges the facts of the disaster, the wind and the lightning, were abundantly established. Then came a large mass of testimony relative to phenomena observed in Europe and America in connection with thunderstorms and tornadoes. Written or printed documents were presented from about twenty meteorologists, including Profs. Alexander G. McAdie and Alfred J. Henry, of the Weather Bureau. Considerable time was given to the study of analogous cases of destruction by other tornadoes, such as that of Monville, August 19, 1845; St. Claude, August 19, 1890, and an elaborate study was made of the destruction in the present case, Dijon, June 30, 1901, most of which was evidently due to wind. After three days of pleading, the civil tribunal of Dijon finally rendered its judgment substantially in accord with the opinion of two of the three experts, namely, Galliot, engineer-in-chief of bridges and roads; Pigeon, professor in the faculty of sciences at the University of Dijon, and Julien, civil engineer in Paris.

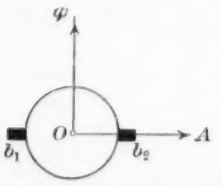
Commutation in Alternating-Current Motors at Starting.

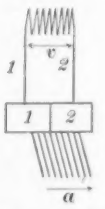
BY MARIUS LATOUR.

THE object of this article is to present some precise considerations relating to the special conditions of commutation at starting, of alternating-current commutator motors. Although the following remarks may apply to polyphase motors, I have particularly in view the single-phase motor. As I have pointed out elsewhere, the main difficulty in the operation of commutator motors relates to commutation at starting. In reality, in all kinds of single-phase motors, the starting is produced in the same way, viz : on the principle of operation of the straight series motor. Referring to Fig. 1, we have an alternating field, $O\,\phi$, and a certain ampere-turn vector, $O\,A$, perpendicular to the direction of the field. The brushes, $b_1 b_2$, short-circuit some sections which are the seat of certain e.m.f's induced by the variation of the field.

I will define the capacity of a single-phase motor as that corresponding to the highest torque it can develop at starting, with a satisfactory commutation.[1]

Let us assume that C is the maximum torque and ω the angular speed of the motor at its maximum number of revolutions. The





FIGS. 1 AND 2.—COMMUTATION IN ALTERNATING-CURRENT MOTORS.

product, $C\,\omega$, expressed in horse-power, is what I call the capacity of the motor. If the maximum speed corresponds to m times the synchronous speed (m being greater or less than 1), the quantity, $\frac{C\,\omega}{m}$, expressed in kilowatts, will be the apparent power called into play at the commutator at starting. By apparent power I mean the product of the voltage, V, developed at the commutator in a direction perpendicular to the line, $b_1 b_2$, and the current, I, introduced through the brushes, $b_1 b_2$.

Let us call t the peripheral speed of the commutator in centimeters per second; f the frequency of the supplied current; v the voltage developed in the commutator along an arc corresponding to the width, a, of a brush. The length of the arc of the commutator corresponding to one pole will be $\frac{t}{2\,f\,m}$, and the voltage developed on the commutator will be

$$V = \frac{t}{2\,f\,m} \cdot \frac{v}{a} \cdot \frac{2}{\pi} = \frac{v\,t}{\pi\,a\,f\,m}.$$

The apparent power will be

$$\frac{v\,t}{\pi\,a\,f\,m} \cdot I,$$

P being the capacity of the motor expressed in kilowatts. We shall then have

$$\frac{P}{m} = \frac{v\,t}{\pi\,a\,f\,m} I.$$

It follows that

$$v\,I = \frac{\pi\,a\,f}{t} \cdot P. \qquad (1)$$

We shall first assume that a bar is as wide as the brush, and we shall suppose that no resistance connections are used between the armature and the commutator bars. Let us suppose that a line of brushes corresponds to a single brush having a total section of $a \times l = s$, l being the length of the brush along the length of the commutator. With the densities of current which are used at starting, we shall assume that the contact resistance per square centimeter, ρ, is the same at all densities.

We shall designate (see Fig. 2) by s_1, the surface of contact between the brush and the bar, 1, and by $s_1 = s - s_1$ the surface of contact between the brush and the bar, 2.

At starting the commutator revolves, by definition, at an infinitely reduced speed, so that the distribution of the currents is not disturbed by the self-induction of the short-circuited section. The division of the current, I, introduced through the brush and the value of the short-circuit current, I_1, are merely regulated by the ohmic resistances.

The currents, I and I_1, are in quadrature. Under these conditions the total heat liberated at the commutator is equal to the sum of the heat that each of these currents would liberate separately.

The resistance of the short-circuited section may, in any case, be neglected.

According to Fig. 2, the current, I, is divided between the conductors, 1 and 2, as follows:

Conductor 1: $$I \cdot \frac{\frac{\rho}{s_2}}{\frac{\rho}{s_1} + \frac{\rho}{s_2}}.$$

Conductor 2: $$I \cdot \frac{\frac{\rho}{s_1}}{\frac{\rho}{s_1} + \frac{\rho}{s_2}}.$$

The power liberated at the commutator is, consequently, for any value of s_1, $I^2 \frac{\rho}{s}$. The short-circuit current, I_1, is equal to $\frac{v}{\frac{\rho}{s_1} + \frac{\rho}{s_2}}$. The power liberated on the commutator by the current I_1 is then $\frac{v^2}{\frac{\rho}{s_1} + \frac{\rho}{s_2}}$. The *average* power liberated by this current, at an infinitely reduced speed, corresponding to all possible values of S_1, will be:

$$\frac{1}{s} \int_0^{s_1} \frac{v^2}{\frac{\rho}{s_1} + \frac{\rho}{s - s_1}}\, d\,s_1 = \frac{v^2}{6\,\frac{\rho}{s}}.$$

The sum of the average power liberated at the commutator is, consequently:

$$p = I^2 \frac{\rho}{s} + \frac{v^2}{6\,\frac{\rho}{s}}.$$

[1] This term will be defined farther on.

The value of the product, $I\,v$, is fixed by the capacity of the motor (see equation [1]). It is, therefore, a constant.

From this remark, and taking into consideration the preceding equation, we see that the heating on the commutator will be a minimum when the losses due to the line current, I, are equal to the losses due to the short-circuit current, I_1.

We have then to verify the relation:

$$I^2 \frac{\rho}{s} = \frac{v^2}{6\,\frac{\rho}{s}}.$$

$$\text{or} \qquad I^2\left(\frac{\rho}{s}\right)^2 = \frac{v^2}{6},$$

$$\text{or} \qquad \sqrt{6}\, I \frac{\rho}{s} = v. \qquad (2)$$

$I \frac{\rho}{s}$ represents the ohmic drop due to the flow of the current, I.

Let us call this drop k. We then obtain for the best value of v

$$v = \sqrt{6}\, k.$$

The power liberated in the form of heat per square centimeter of brush area will be

$$\frac{I^2}{s^2}\rho + \frac{v^2}{6\rho}.$$

This power should not exceed a certain value, q, in order to insure satisfactory commutation. *The value of q defines, from my point of view, the quality of the commutation.* We have then to verify the relations:

$$v\,I = \frac{\pi\, a\, f}{t} \times P, \qquad (1)$$

$$\sqrt{6}\, I \frac{\rho}{s} = v, \qquad (2)$$

$$\frac{I^2}{s^2}\rho + \frac{v^2}{6\rho} = q. \qquad (3)$$

Let us deduce I and v in terms of ρ and s, from the equations (2) and (3). We then obtain:

$$I = s\sqrt{\frac{q}{2\rho}} \quad ; \qquad v = \sqrt{3\,q\,\rho}$$

Multiplying the two quantities, we have

$$I\,v = s\,q\sqrt{\frac{3}{2}} = \frac{\pi\, a\, f}{t} \cdot P.$$

It follows:

$$s = \frac{\pi\, a\, f}{q\, t}\sqrt{\frac{2}{3}} \cdot P,$$

$$l = \frac{\pi\, f}{q\, t}\sqrt{\frac{2}{3}} \cdot P.$$

We then arrive at the conclusion that, for a given commutation, the necessary rubbing surface is independent of the type of motor (series or repulsion) of the voltage of the rotor, of the quality of the brushes, of the number of poles, and of the speed of the motor. The total length of brushes of the same polarity is independent of the width of the brush.

Let us now consider the case when the width of the bars is less than that of the brush, a. Let us consider for this purpose that instead of a single winding on the rotor we dispose n separate parallel windings, corresponding to the same number of commutator sections each as the first single one. We shall obtain n bars under the brush (see Fig. 3). The n parallel windings being constantly in service, the commutation of the current, I, will be excellent in any case.

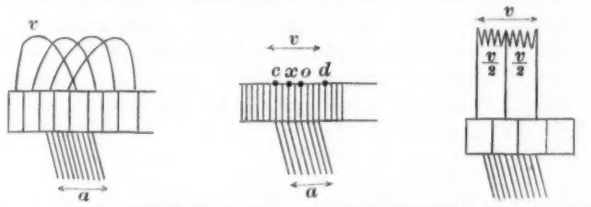
If we now calculate the power liberated by the short-circuit current we see that it is reduced to

$$\frac{\frac{1}{s}}{\frac{}{n}} \int_0^{\frac{s}{n}} \frac{v^2\, d\,s_1}{\frac{\rho}{s} + \frac{\rho}{\frac{s}{n} - s_1}} = \frac{v^2}{6\,n\,\frac{\rho}{s}}$$

If we had an infinite number of parallel windings corresponding to an infinite number of infinitely thin bars under the brush, it would remain only the infinitely small losses at the leading and trailing edges of the brush, which losses it would be possible to avoid at the limit by letting the brush cover only $(n - 1)$ commutator bars.

In continuous current the conception of the theoretical commutator implies an infinite number of bars (corresponding to a perfectly continuous current); in alternating current the conception of the theoretical commutator implies an infinite number of bars of a higher order, and this conception is besides bound to the conception of an infinite number of parallel circuits.

We shall now consider the case when, instead of using n parallel windings, we divide every section of Fig. 2 into n sections in series



FIGS. 3, 4 AND 5.—COMMUTATION IN ALTERNATING-CURRENT MOTORS.

(see Fig. 4). The brush, the width of which is still a, will cover again n bars. In making the purely theoretical supposition that we divide each section of the winding into an infinite number of sections, we see that the brush will cover an infinite number of infinitely thin bars (see Fig. 4). The difference of potential between the extreme bars, c and d, covered by the brush will always be v. One can easily calculate again the loss of energy due to the short-circuit current. The potential along the surface of the commutator under the brush varies proportionately to the distance. If we consider zero potential as existing at the middle, O, of the brush, the potential at any distance, x, from the point, O, will be $\frac{v}{2}\frac{x}{OC}$, and the power dissipated in the contact surface between O and C will be

$$\int_0^{OC} \frac{v^2}{4} \frac{x^2}{OC^2} \frac{1}{\frac{\rho}{l\,dn}} = \int_0^1 \frac{v^2}{4\rho} \frac{x^2}{OC^2}\, l\, \frac{OC \times dx}{OC} = \frac{v^2\, OC \times l}{12\,\rho}.$$

The power dissipated on the contact surface under the entire brush will be

$$\frac{2v^2\, OC \times l}{12\,\rho} = \frac{v^2}{12\,\frac{\rho}{s}}.$$

We see then that the energy dissipated by the short-circuit current can be reduced, at the best, to one-half of the dissipated energy when the section is not divided.

In the particular case where the original section is only divided in two (that is when the brush covers two commutator bars (see Fig. 5), it can be easily proved that the loss of power, due to the short-circuit current, is

$$\frac{v^2}{6\,\frac{\rho}{s}} \cdot \frac{5}{8}.$$

The best values of v, s and l are then, respectively,

$$v = \sqrt{\frac{6.8}{5}} \cdot K$$

$$s = \frac{\pi\, a\, f}{t\, q}\sqrt{\frac{5}{12}}\,.\,P,$$

$$l = \frac{\pi f}{t q}\sqrt{\frac{5}{12}}\,.\,P.$$

In reality it is necessary to multiply the two last expressions by 2 to take account of the fact that we need another system of brushes of the same total length for the opposite polarity, and we must write:

$$s = \frac{2\pi\, a\, f}{t\, q}\sqrt{\frac{5}{12}}\,P = 4\,\frac{a f}{t q}\,P$$

$$l = \frac{2\pi\, f}{t\, q}\sqrt{\frac{5}{12}}\,P = 4\,\frac{f}{t q}\,P$$

The power dissipated on the commutator will be, in any case,

$$p = 4\,\frac{a f}{t}\,P.$$

It may be remarked that this power depends neither on the dimensions of the commutator nor on the kind of brushes used.

Let us assume that μ represents the pressure on the brushes, expressed in kilowatts per square centimeter. The power liberated by friction will be, with usual carbon brushes (see Arnold):

$$p_s = .08\,\mu\,\frac{a f}{q}\,P$$

The friction losses do not depend on the peripheral speed assumed for the commutator, but only on q and n.

Numerical example:

$f = 25$,
$a = 9$ mm. (corresponding to commutator bars of 4.5 mm.),
$t = 20$ meters per second,
$q = 25$ watts,
$\mu =$ kg. 4,
$P = 7{,}500$ watts (corresponding to a 100-hp motor, as defined above).

We obtain:

$l = 1.50$ m,
$p = 3.375$ kw.,
$p_1 = 2.160$ kw.

We can obtain the length, l, by utilizing four lines of brushes of 37 centimeters each. At a frequency of 15 periods we should have four lines of brushes of 24 centimeters.

Navy Wireless Telegraphy.

The Navy Department has issued a circular giving the conditions under which civilian interests can obtain the benefit of coastwise wireless telegraphy.

The facilities of the naval coastwise wireless telegraph stations, including the one on the Nantucket Shoals Lightship, for communicating with ships at sea, where not in competition with private wireless telegraph stations, are placed at the service of the public generally and of maritime interests in particular under the rules established herein for the purpose of:

(*a*) Reporting vessels and intelligence received by wireless telegraphy with regard to maritime casualties, derelicts at sea and overdue vessels.

(*b*) Receiving wireless telegrams of a private or commercial nature from ships at sea for further transmission by telegraph or telephone lines.

(*c*) Transmitting wireless telegrams to ships at sea.

For the present this service will be rendered free. All messages will, however, be subject to the tariffs of the ship stations and land lines. Arrangements have been made with both the Western Union and Postal Telegraph Companies for forwarding messages received from ships at sea. When a message is not prepaid the company delivering it will collect the charges.

The Nantucket Shoals Lightship station will report vessels and transmit messages from them if the signals are made by the international code or any other known to the operators on the lightship.

When notified by the Weather Bureau of the Department of Agriculture naval wireless telegraph stations will give storm warnings to vessels, communicating with them by wireless telegraphy.

All vessels having the use of the naval wireless telegraph service are requested to take daily meteorological observations of the weather when within communicating range, and to transmit such observations to the Weather Bureau by wireless telegraphy at least once daily, and transmit observations oftener when there is a marked change in the barometer.

All ship owners desiring to use any special code of signals for communicating with the Nantucket Shoals Lightship station or any of the shore stations, or make any other special arrengements, are requested to communicate with the Bureau of Equipment, Navy Department, Washington, D. C.

Naval wireless telegraph stations are equipped with apparatus of several systems and can communicate with all the principal wireless telegraph systems now in use if tuned to the same wave length.

The following stations are fully manned and will be prepared to receive messages at all hours, except in case of some accidental breakdown: Navy Yard, Portsmouth, N. H.; Cape Ann (Thatcher's Island); Highland Light, Cape Cod, Mass.; Nantucket Shoal Lightship; Torpedo Station, Newport, R. I.; Montauk Point, L. I.; Navy Yard, New York; Highlands of Navesink, N. J.; Cape Henry, Va.; Navy Yard, Norfolk, Va.; Dry Tortugas, Fla.; San Juan, P. R.; Culebra, W. I.; Yerba Buena Island, Cal.; Navy Yard, Mare Island, Cal.

It is expected that the following stations will be in operation in a few weeks, fully manned to receive messages at all hours: Navy Yard, Boston, Mass.; Cape Elizabeth, Me.; Naval Station, Key West, Fla.; Navy Yard, Pensaloca, Fla.; Naval Station, Guantanamo, Cuba; Panama Canal Zone; Farallon Islands, Cal.; Naval Station, Cavite, P. I.; Cabra Island, P. I.

The Bureau of Equipment expects to erect wireless telegraph stations at the principal points along the coast of the United States and at points in its insular possessions. As fast as they are completed they will be open for public use, under the regulations established herein.

The Nantucket Shoals Lightship will transmit its messages to the Torpedo Station, Newport, R. I. All messages intended to be sent via this lightship to ships at sea should be sent to the Torpedo Station.

Messages for the Montauk Point wireless telegraph station will also be sent via the Torpedo Station, Newport, R. I.

A vessel wishing to communicate with a station (and having ascertained by "listening in" that she is not interfering with messages being exchanged within her range) should make the call letter of the station at a distance not greater than seventy-five miles from it.

The call should not be continuous, but should be at intervals of about three minutes, in order to give the station a chance to answer.

After the station answers the vessel should send her name, distance from station, weather and number of words she wishes to send, and then stop until the station makes "O. K.," signals the number of words she wishes to send to vessel and signals go ahead.

Then the vessel begins to send her messages, stopping at the end of each fifty words and waiting until the station signals "O. K." and "go ahead." When all messages have been sent she will so indicate. If the sender desires to designate the Western Union or the Postal Telegraph system for further transmission of his message he should do so immediately after the address.

In order to obtain the best results both sending and receiving apparatus should be tuned to wave length of 320 meters. Until further notice the speed of sending should not exceed twelve words per minute.

Marconi Station at Cape Race.

The Marconi wireless station at Cape Race has been completed. The Allan Line steamer *Tunisian* was the first ship to speak with it. The vessel remained in communication with the station nine hours and obtained news of the result of the Presidential election in the United States and other happenings. The Canadian cruiser *Minto* tested the efficiency of the station from a point 150 miles to seaward. This was one of a series of tests made by the Canadian Government in the interests of the St. Lawrence route.

Niagara Power in Buffalo.—I.

BUFFALO absorbs more transmitted water power than any other city in the United States. This energy is drawn from the great power houses at Niagara Falls, some twenty miles away, and operates the street railway as well as the entire electrical supply system at Buffalo. Connected to this electrical supply system are many industrial plants whose individual lighting and motor requirements run into hundreds of horse-power, and represent some of the largest manufacturing enterprises of the city. In the list of these large consumers of power are shipbuilding plants, railway shops, manufacturers of heavy pumping machinery, rubber works, cereal mills and grain elevators of the largest size.

These results with electrically transmitted water power have been reached in large part during the past four years, in a city where the car load prices for run of mine coal vary around two dollars per ton, where natural gas with its 1,000 heat units per foot sells for 30 cents per 1,000 cubic feet, and where the rate for illuminating gas is one dollar per thousand.

The transmitted energy reaches the terminal house at Buffalo as 22,000-volt, three-phase, 25-cycle current, and is transformed and connected there or at the several sub-stations for distribution in various forms to lamps and motors. Distribution of the transmitted energy at Buffalo is carried on by the Cataract Power & Conduit Company, the Buffalo General Electric Company, and the International Railway Company. The Cataract Power & Conduit Company receives all of the energy at its terminal house, distributes a part of it to private consumers, delivers another part to the Buffalo General Electric Company, and still a third part to the International Railway Company. Electrical supply of all sorts is carried on by the Buffalo General Electric Company, but the International Railway Company distributes current only to its own system.

All of the transmitted energy passes into transformers at the terminal house of the Cataract Power & Conduit Company, which reduce the voltage from 22,000 to 11,000, and have a combined capacity of 20,250 kw, or 27,000 hp, thus fixing approximately a maximum limit for the Buffalo load. As may be seen from the load curve of the Cataract Company for last December, this limit has been nearly reached, and additional transformers will soon be necessary. In comparing the load curves of the three companies above mentioned, it should be noted that the Cataract Company supplies all of the energy distributed by the General Electric Company, and also all of that distributed by the Railway Company in Buffalo between May first and October first of each year. In other months the Railway Company operates a steam power station to carry a part of the peak load.

DISTRIBUTION BY CATARACT POWER & CONDUIT COMPANY.

Buffalo leads the world in the capacity of stationary electric motors operated by transmitted water power. Disregarding the motor-generators in the sub-stations of the Buffalo General Electric Company and of the International Railway Company, the total rating of motors supplied by the lines of the Cataract Company amounts to 18,124 hp. This figure takes no account of the consumers' motors that are connected to the lines of the General Electric Company. For the general supply of consumers the Cataract Company distributes only 2,200-volt, 25-cycle, three-phase current, and as a rule its customers are those who have a large capacity in induction motors. These customers may be divided into three groups, namely, those who formerly operated steam plants in Buffalo but have shut these plants down in order to use the Niagara power, those who have moved from other locations to that city in order to take advantage of the electric power, and those who have started entirely new enterprises in Buffalo and equipped in the beginning for the electric current, instead of gas or steam power. In all except three cases the distribution pressure of 2,200 volts is reduced to some lower figure by transformers on the premises of consumers. Dividing the customers of the Cataract Company into the three groups just suggested, it appears that 24 new enterprises have started in Buffalo and installed an equipment for electric power instead of a steam plant. Manufacturing plants to the number of 13 have been moved from other locations to Buffalo, and have there begun the use of Niagara power, and 36 large consumers have abandoned the operation of their existing steam plants in order to share in the advantages of this same power. In a city where good steam coal costs only two dollars per ton, and where natural gas sells for 30 cents per thousand feet, this is certainly an instructive example of what can be done with transmitted water power. It is to be noted also that some of the largest power users connected to the electric system are those who have steam plants lying idle in Buffalo. Thus the Buffalo Dry Dock Company, which formerly used steam power, has an equipment of 576 hp in electric motors, and the Snow Steam Pump Works, which also have an idle steam plant, are equipped with motors of 2,031 aggregate hp. In nearly all cases electric light as well as motive power is supplied, and in a few instances the lighting is greater than the motor load.

For the 73 large consumers connected to the lines of the Cataract Company the total transformer capacity is 12,517 kw, the number of incandescent lamps 18,642, and the rating of motors 18,124 hp, as already stated. Of these consumers, 42 have motor equipments of 100 hp or over capacity each; 11 have individual motor plants of not less than 500 hp; three consumers use motors that have a combined rating of more than 1,000 hp each, and in one case the capacity of motors reaches more than 2,000 hp.

The details of equipment in some of these large plants are instructive, as showing the very heavy classes of work that are being carried on with transmitted water power, and the character of the units adopted for the purpose. One plant of this sort is that of the Mutual Elevator Company, engaged in handling grain. At this plant the 2,200-volt, three-phase, 25-cycle line current is received by two oil-insulated transformers of 500 kw each, that step down to 420 volts for three-phase induction motors. Of these motors four are rated at 100 hp, nine at 50, four at 75, two at 20, two at 10 and six at 5 hp each, making a total of 1,240 hp. This elevator is one of the new Buffalo enterprises that have used Niagara power from the start. Another interesting plant is that of the Spencer Kellog Company, which contains one 500 and one 100-hp, 2,200-volt, three-phase induction motors, two oil-insulated transformers that step from 2,200 down to 220 volts, and two more of like capacity for 110 volts, and a 10-hp, 220-volt induction motor for crane use. This company has shut down its steam plant in order to use the transmitted water power. The United States Rubber Company Works, which formerly operated with steam power, are now driven by one 1,200 and one 200-hp, 2,200-volt, three-phase induction motors, and have a 30-kw,. oil-insulated transformer that steps current down from 2,200 to 220 or 110 volts for lighting. This 1,200-hp motor has an external resistance in its rotor circuit to keep down the amount of starting current, and the motor circuits pass through automatic oil circuit-breakers. At the Snow Steam Pump Works there are three 115-kw transformers that step the three-phase currents from 2,200 to either 72 or 142 volts, three 100-kw transformers that lower the line pressure to 460 volts, two 75-kw transformers that with 2,200 volts primary give either 440, 142 or 72 volts secondary, and two 25-kw transformers of 2,200 volts primary and either 110 or 220 volts secondary. The transformers that step down to 142 volts secondary supply current to one 300-kw and one 50-kw rotary converter of 220 volts. In these works and devoted mainly to the operation of machine tools there are 37 induction motors, 440-volt, three-phase, with an aggregate capacity of 837 hp, and 70 direct-current motors in sizes of ½ to 50 hp, and with a total of 1,194 hp rating. All of the transformers in this plant are oil-insulated.

Below there are given in brief the transformer, converter and motor equipments of a few of the other important consumers on the lines of the Cataract Company. In each case three-phase, 25-cycle, 2,200-volt current is delivered to the transformers and only the secondary voltages are stated. All transformers are oil-insulated and all motors are of the three-phase induction type unless given as direct current or synchronous. Induction motors operate at the transformer voltages where no other is given.

Buffalo Elevating Company:

Three 100-kw and two 75-kw, 440-volt transformers; two 7½ kw, 110 or 220-volt transformers; three 100-hp, two 75-hp and two 50-hp motors.

George Urban Milling Company:

One 20-kw transformer of 220 or 440 volts, and two 7½-kw transformers of 110 or 220 volts; one 400-hp, 2,200-volt, synchronous motor; one 20-hp, 220-volt motor.

American Radiator Company:

Three 125-kw, 220 or 440-volt transformers; two 75-hp, one 50-hp, one 20-hp, five 15-hp, eight 10-hp, two 7½-hp, three 5-hp and five 3-hp motors.

Buffalo Dry Dock Company:

Two 100-kw, 220-volt transformers; forty motors of 1 to 75 hp; several for crane.

Electric Grain Elevator:

Two 165-kw, 220-volt transformers; four 75-hp, three 50-hp and one 40-hp motor.

Delaware, Lackawanna & Western Railway Shops:

Three 50-kw, 220 or 440-volt transformers and three 50-kw, 210 or 420-volt transformers; one 40-hp, one 30-hp, four 20-hp, one 50-hp, two 15-hp, five 10-hp, five 7½-hp, three 5-hp and two 3-hp motors.

Charles G. Curtiss Co.:

Three 50-kw transformers for 110, 200 or 400 volts; six 50-hp and one 15-hp motor.

Buffalo Foundry Company:

Three 125-kw transformers for 74, 148 or 230 volts; one 800-amp., 230-volt, rotary converter; one 75-hp, two 50-hp, one 40-hp and one 30-hp induction motors; one 20-hp, one 15-hp, one 10-hp and one 5-hp, 220-volt, direct-current motors.

National Battery Company:

Two 100-hp, 2,200-volt motors, each direct-connected to a 75-kw, 125-volt, direct-current dynamo.

McKinnon Dash Company:

One 150-hp and one 100-hp, 2,200-volt motor; one 75-kw, direct-current dynamo; one 60-kw welding dynamo; a number of small, direct-current motors.

Buffalo Fertilizer Company:

Three 50-kw transformers for 220 or 440 volts; one 75-hp, one 50-hp and two 30-hp motors.

J. N. Adam & Co. Department Store:

One 100-hp, 2,200-volt motor, direct-connected to a 75-kw, 110-volt, direct-current dynamo, for arc lighting.

Genesee Hotel:

Four 25-kw transformers for 110, 220 or 440 volts; one 30-hp, two 15-hp and one 5-hp motor.

Iroquois Brewing Company:

Two 50-kw, 420-volt transformers; one 10-kw, 105-volt transformer; one 40-hp, one 7½-hp, one 5-hp and three 3-hp motors.

Laverack Building, Department Store:

Three 20-kw transformers of either 110 or 220 volts for lighting; two 20-kw transformers of either 110 or 220 volts for elevator motors; two 20-hp crane type motors for elevator service.

Besides the 18,124 hp in motor capacity on the premises of the 73 large consumers mentioned, the Cataract Company is under contract to operate a 1,500-hp, 2,200-volt, three-phase, 25-cycle synchronous motor for the Buffalo city water works as soon as it is installed. This motor is to be direct-connected to a vertical turbine pump of 25,000,000 gallons nominal capacity. With some smaller additions, this water works motor will presently raise the total rating of motors connected to the lines of the Cataract Company above the 20,000-hp mark, without regard to machines in the sub-stations of the railway company and the Buffalo General Electric Company.

As may be seen from the details of equipments in important plants above named and in others covered by the appended list, the capacity of transformers installed with a motor equipment is often much less than that of the motors which they supply with current. This excess of motor capacities is the more notable in view of the fact that the same transformers frequently operate also a large number of lamps. An illustration of this practice may be seen in the plant of the Buffalo Dry Dock Company, where the total transformer capacity is only 200 kw, and the aggregate rating of motors is 576 hp. Besides these motors there are also connected 1,900 incandescent lamps. As to the lamps it may perhaps be said that they are mainly used at hours when the motors are not wanted, but the large excess of motor over transformer capacity seems to be due to the intermittent use of the latter. This brings out one of the well-known advantages of electric motive power, namely, that the friction and other losses are cut down to those in the machines actually operating at any particular time.

Another similar instance is that of the Iron Elevator & Transfer Company, which has a transformer capacity of 307 kw and motors with an aggregate rating of 885 hp, besides 130 incandescent lamps. In the Snow Steam Pump Works the capacity of transformers is 845 kw, and the aggregate rating of motors which they supply, either directly or through converters, is 2,031 hp. These works also contain 1,500 incandescent lamps that depend for current on the transformers just named.

It seems notable that only six of the 73 power installations of consumers already mentioned include 2,200-volt motors, but nearly all use motors of about 440 volts fed through transformers. This is the practice in spite of the fact that many of the plants include motors of 50, 75 and 100 hp each. In the six plants where 2,200-volt motors are employed the ratings of single motors operating at this pressure are 100, 150, 200, 400, 500 and 1,200 hp each, there being five motors of the 100-hp size, and one of each of the other capacities named. Induction motors seem to have the general preference among these large power users, as in the twenty plants of which details were given only one includes a synchronous motor. The latest large installation, that of the Buffalo water works above named, differs from nearly all of the others in that the 1,500-hp motor is synchronous and operates at 2,200 volts. The single synchronous motor now in operation among the twenty plants described is of 400 hp capacity and operates at 2,200 volts.

Another notable feature of this electric power distribution in large plants, as disclosed by the detailed lists of apparatus in twenty installations, is the very general use of alternating rather than direct-current motors, and the small number of cases in which conversion to direct current has been found desirable. Of the twenty plants whose details are given, the alternating current is converted in only five, and in one of these the resulting direct current is employed only for arc lighting. The nature of the current conversion in these five plants is stated below. The McKinnon Dash Co. drive a 60-kw welding machine and a 75-kw, 110-volt dynamo with its induction motors, and the 110-volt, direct-current operates both lamps and small motors. In the plant of the National Battery Company the two induction motors drive two 75-kw, 125-volt, direct-current dynamos which operate four arc and 222 incandescent lamps, but seem to be devoted mainly to the manufacture of storage batteries, where direct current is, of course, necessary. With a part of their 837 hp capacity in induction motors the Snow Steam Pump Works drive rotary converters of 350 kw total capacity, and these in turn are devoted to the operation of direct-current motors and of arc and incandescent lamps. A single rotary converter of 200 kw rating is driven by a part of the 245-hp capacity of induction motors, and is connected with direct-current motors having a combined rating of 50 hp, and some arc and incandescent lamps, in the shops of the Buffalo Foundry Company. In the department store of J. A. Adam & Co. the induction motor drives a 75-kw, 110-volt dynamo for the operation of arc lamps in multiple. Induction motors are used to operate cranes at the works of the Buffalo Dry Dock Company, and elevators in the Laverack Building, and are probably doing variable-speed work elsewhere.

There is a tendency to drive large sections of manufacturing plants with single motors in some cases, as is made evident by the sizes and numbers of the motors employed. Thus the Spencer Kellog Co. divides its power between one 10-hp, one 100-hp and one 500-hp motor. In the works of the George Urban Milling Company the power is developed by one 20-hp and one 400-hp motor, and the United States Rubber Reclaiming Works operate with one 200-hp and one 1,200-hp motor. Some of these plants that operate entirely with electric power are among the largest of their kinds in the country, and do some of the heaviest classes of work. A large plant in its line is that of the John Kam Malting Company, which has a daily capacity of 4,200 bushels of seven-day malt, and is operated with electric motors that have a combined rating of 610 hp. The Buffalo Foundry Company, whose only power is developed by electric motors, pours single castings of as much as 70 tons weight from ladles operated by electric cranes. In the foundry of the Pratt & Letchworth Company, who use the transmitted water power exclusively to light and operate their plant, cast steel frames for the largest steam locomotives are poured, and it is interesting to note that such frames are said to be displacing those of hammered steel, which have been in general use up to this time. In this same foundry there have recently been cast the large bipolar motor frames for the electric locomotives that are now under construction for the New York Central & Hudson River Railroad.

It should not escape attention that transmitted water power has displaced steam power in the large industries of Buffalo, not only in cases where the amount of power used is very large, but also where steam plants must be continuously operated for industrial heating. Examples of this latter sort are seen in the two large malt works, the three cereal mills and a tannery plant that draw all of their power from the electric supply lines, but generate steam at all times of year for other uses.

Much difference of opinion has existed as to adaptation of alter-

nating current at 25 cycles per second to incandescent lighting, the fear being expressed by some engineers that this rate of alternation would produce a noticeable waver in the light of the carbon filament. The work done at Buffalo seems to go far toward settling this question, for thousands of incandescent lamps are being regularly operated there with the 25-cycle current. Much the greater part of the 18,642 incandescent lamps in use by the 73 large customers of the Cataract Company are operated by the 25-cycle current without conversion. Of course, many of the plants using these low-frequency lamps are factories, where the requirements for steady light are not, perhaps, as exacting as are those in regular commercial service. Some of the customers using the 25-cycle current for incandescent lamps, however, want the best light that they can get, and two of these may be mentioned. One is the Laverack Building, a department store, where the 2,200-volt, 25-cycle current is transformed to 220 volts for the incandescent lighting, which is done by 763 lamps. As 220-volt lamps are more sensitive to current changes than are those of lower voltage, the fact that these lamps are giving satisfactory light in a department store seems to be a strong argument in favor of 25-cycle current. Another example of similar sort is that of the Genesee Hotel, where the 25-cycle current is stepped down to 110 volts for the operation of 1,200 incandescent lamps. On the basis of the experience gained in the plants mentioned, plans are under way for a large extension of the incandescent lighting service with 25-cycle current in Buffalo. In line with these plans the Buffalo General Electric Company, instead of increasing its equipment for the conversion of current from 25 to 60 cycles per second, will supply additions to its incandescent load with current of the lower frequency.

The use of Niagara power has increased rapidly in Buffalo during the past three years and there is little doubt that the completion and operation of the great plants now under construction at the falls will send it forward at an even faster rate. For the month of December, 1901, the number of kilowatt-hours distributed by the Cataract Company was 5,259,400; in 1902 the corresponding figure was 6,424,120, and in 1903 it amounted to 7,073,700 kw-hours. During the entire year of 1902 the energy distributed by this company was 57,927,580 kw-hours, and in 1903 it rose to 64,901,080 kw-hours.

The agent of a large coal mining company at Buffalo expressed to the writer the opinion that the use of Niagara power there had not affected the demand for coal. This opinion seems to be in the main correct, for the 64,901,080 kw-hours of energy from Niagara Falls, delivered in Buffalo during 1903, represents the work in power production of only 129,802 short tons of bituminous coal, on the basis of 4 pounds of coal for each kw-hour of energy. This ratio of coal and energy is probably more favorable to the former than the average of actual results in the manufacturing plants and large commercial buildings of Buffalo. During the year of 1903 the net imports of bituminous coal at Buffalo amounted to 3,104,623 net tons, according to statistics compiled by the Chamber of Commerce there, and the quantity above estimated as displaced by electrical energy represents only about 4 per cent. of this importation. But the near future may tell a different story. The capacity of transformers in the terminal house of the transmission lines at Buffalo is now 27,000 hp, but the new plants under construction at Niagara Falls are to have an ultimate capacity of more than 600,000 hp, and a large fraction of this power seems certain to find its way to Buffalo. A large percentage of the soft coal consumed in Buffalo is, of course, devoted to the production of heat alone, as is nearly all of the anthracite coal there, and in this field it will be a long day before electric water power makes serious inroads, with coal at Buffalo prices. In the production of power, however, there seems to be no good reason why energy from Niagara Falls should not shut down every steam engine and gas engine in the city.

Low rates for electric current are the key to the great expansion of the power business of the Cataract Company in Buffalo. The power rates of this company are partly on a flat and partly on a meter basis in the case of each customer. Rates are figured on 2,200-volt, three-phase, 25-cycle current delivered at the premises of consumers, and each consumer supplies his own transforming and converting apparatus. The flat rate to which each consumer is subject is one dollar per month per kilowatt, or 75 cents per month per horse-power, of his maximum demand for power at any time. Thus a consumer who uses at times as much as 100 hp must pay a flat rate of $75 per month, or $900 per year. Besides this flat rate the consumer must pay a meter rate based on the total amount of energy that he uses per month, and without regard to his maximum demand for power. In a case where the average use of current amounts to 50 hp of continuous work during ten hours per day, and 25 days per month, the horse-power-hours of energy per month reach 25 x 10 x 50, or 12,500. For this consumption of energy per month the meter rate is 0.6 cent per horse-power-hour, so that the meter charge for the 12,500 hp-hours would be 12,500 × 0.6 = 7,500 cents or $75. As the flat rate that must be paid by every consumer who uses as much as 100 hp at any one time is $75 per month, the total monthly charge to the consumer who uses 50 hp for 250 hours on an average, but at times draws energy at the rate of 100 hp from the line, amounts to 75 + 75 or $150. This gives a monthly rate of $3, or a yearly rate of $36, for each horse-power actually used during ten hours per day and 25 days per month. Regarding this entire charge as one based on the maximum power used at any one time, it amounts to only 1.5 dollars per month, or $18 per year per horse-power.

If the consumer whose case has just been considered is able to reduce his maximum demand for current to 50 hp, but continues to use 12,500 hp-hours per month, either by operating at full load

CUSTOMERS OF THE CATARACT POWER & CONDUIT CO.

	Transf. Capacity, K.W.	16-cp lamps.	Motor Capacity, H.P.
American School Furniture Company	60	....	25
American School Furniture Comapny	75	....	65
J. N. Adam & Company	....	....	100
Acme Steel & Malleable Iron Works	75	350	40
†American Matting Company	165	300	190
*American Brake Shoe & Foundry Company	77½	150	80
*American Radiator Company	375	402	420
†Buffalo Foundry Company	375	310	300
Buffalo Pitts Company	150	150	145
Buffalo Pitts Company	155	135	85
Buffalo Weaving & Belting Company	165	200	150
†Buffalo Gasolene Motor Company	40	125	30
†Buffalo Box Factory	150	200	200
*Buffalo Fertilizer Company	150	25	185
*Buffalo Rubber Manufacturing Company	8	35	4
Buffalo Dry Dock Company	200	1900	576
†Barcalo Manufacturing Company	75	180	101
Buffalo Structural Steel Company	50	....	45
*Buffalo Brake Beam Company	22½	13	23
Empire Bridge Company	130	77	120
†Buffalo Cereal Company	450	140	550
†Buffalo Dental Manufacturing Company	30	200	21
Collins Baking Company	50	150	57½
American Agricultural Chemical Company	300	283	280
The Crosby Company	75	352	62½
†Charles G. Curtiss Company	150	164	315
Cumpson Prentiss Coffee Company	35	30	30
†Buffalo Elevating Company	765	357	930
Delaware, Lackawanna & Western R.R. Shops	300	....	331
H. W. Dopp Company	20	40	10
Jacob Dold Packing Company	200	1100	103½
*Duffy Bros. & Nellis	67½	75	50
†Electric Grain Elevator	330	265	490
Faxon, Williams & Faxon	20	....	26
†Frontier Iron Works	10	....	10
Genesee Hotel	100	1200	65
†Great Eastern Elevator	600	283	842½
R. L. Ginsburg & Sons	85	175	50
†Mutual Elevator Company	1000	300	1240
H. O. Mills	185	....	160
H. O. Mills	475	350	430
*Hygienic Food Company	480	....	400
Iroquois Brewing Company	110	150	61½
†Iron Elevator & Transfer Company	307½	130	885
†Jewett Refrigerator Company	30	63	20
†Keystone Manufacturing Company	43	71	35
†John Kam Malting Company	382½	500	610
Spencer Kellogg Company	60	500	610
Lehigh Valley Railroad Shops	45	....	40
*Lackawanna Steel Company	207½	150	330
†MacLean Box Factory	75	24	70
†Laverack Building	100	763	40
McKinnon Dash Company	....	....	250
*National Battery Company	....	....	200
New York Car Wheel Company	155	28	195
†Niagara Mill & Elevator Company	82	13	75
W. W. Oliver Manufacturing Company	24	....	15
George N. Pierce Company	90	600	70
*Pratt & Lambert	10	100	3
Pratt & Letchworth Company	225	40	266
J. I. Prentiss & Company	20	85	20
†Ryder Belt & Cordage Company	100	150	110
Schoellkopf & Company	90	700	115
Schoellkopf, Hartford & Hanna Company	165	240	105
Snow Steam Pump Works	845	1500	2031
John H. Schmitz	4	....	2
†Sidney Shepard & Company	100	450	137½
†Taylor Signal Company	165	1000	150½
†George Urban Milling Company	35	110	520
United States Hame Company	90	235	100
*United States Head-Light Company	40	275	40
United States Cast Iron Pipe & Foundry Co.	375	35	210
*United States Rubber Reclaiming Works	30	350	1200
Wegner Machine Company	75	26	30
*Wood & Brooks Company	150	250	190
West Manufacturing Company	60	88	50
	12,517	18,642	18,124½

No mark, 36 works that have abandoned steam power.
† 24, new works started in Buffalo.
* 13, works moved to Buffalo.

during ten hours per day or at partial loads for any greater number of hours, the fixed flat rate drops to $0.75 \times 50 = \$37.50$ per month, and the total rate becomes $\$37.50 + \$75 = \$112.50$ per month. This charge is the equivalent of $2.25 per month, or $27 per year for each horse-power used ten hours daily and for 25 days each month. While the flat rate of 75 cents per month or $9 per year for each horse-power of maximum demand remains constant for all powers small and great, the additional meter rate drops to .48 cent per horse-power-hour, where not less than 428 hp is used during the equivalent of ten hours per day and 25 days per month.

With rates like these for electric power it is no wonder that large manufacturing plants are installing motors and steam engines are going out of fashion in Buffalo.

Electromagnetic Torque.

BY A. S. MCALLISTER.

IT is believed that the somewhat unusual conditions for obtaining torque as described below will prove of some interest in view of the present developments in commutator types of alternating-current machinery.

If a bipolar, direct-current armature be placed within core material having uniform magnetic reluctance around the air-gap, as for example within an induction motor stator, and brushes placed upon the commutator in mechanical quadrature, as shown in Fig. 1, be caused to carry direct current from two isolated sources of supply, it will be found that the armature has no tendency to motion in either direction, whatsoever may be the values of the two currents. Upon superficial examination one is inclined to attribute the lack of torque to the fact that such flux as may be in mechanical position to give force by its product with any current existing in the armature is caused by current in the same armature, and the two currents, being in the same mechanical structure, could not cause motion with reference to any external body. It will be evident that each current is in position to produce force in a certain direction due to the presence of the flux caused by the other current. It is not immediately apparent, however, that each component force thus produced tends to give motion to the armature with reference to the stator, and that the cause for the lack of resultant torque is the opposition in direction, with equality in value, of the component forces.

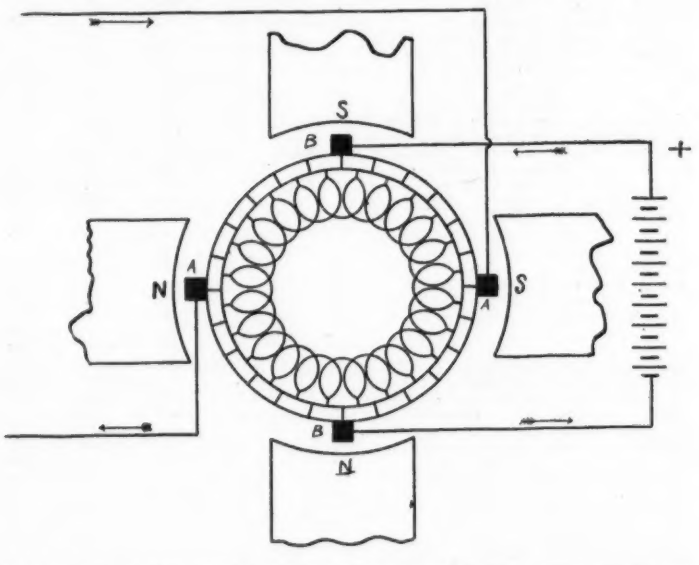


FIG. 1.—SUPERPOSED DIRECT CURRENTS IN ARMATURE. TWO FIELDS IN MECHANICAL QUADRATURE. NO RESULTANT TORQUE.

From the fundamental law of physics, that a force of one dyne is exerted upon each centimeter of length of a conductor per unit current per line of force flux density in the area through which the conductor passes, is obtained the torque equation for the current through brushes $A\,A$ (Fig. 1), due to the presence of the flux caused by the current through the brushes $B\,B$,

$$T_a = K\, I_a\, \phi b^1$$

where K is a proportionality constant depending for its value upon the number and arrangement of the armature conductors.

Similarly, the torque for the current through the brushes $B\,B$ will be

$$T_b = K\, I_b\, \phi_a,$$

the constant, K, having the same value as above.

A study of the circuits and magnets of Fig. 1 will show that these two torques are opposite in direction, so that the resultant torque is

$$T = T_a - T_b = K\,(I_a\, \phi_b - I_b\, \phi_a).$$

With uniform reluctance in all directions across the air-gap and through the core material, the flux per unit current will be the same in both axial brush lines, so that

$$\frac{\phi_a}{I_a} = \frac{\phi_b}{I_b} \quad \text{or} \quad I_a\, \phi_b = I_b\, \phi_a,$$

from which is obtained $T = 0$.

Hence, under the conditions assumed, the resultant torque has zero value, though each component torque may have a certain definite value tending to give motion to the armature.

If the reluctance be greater in the axial line of one set of brushes than in that of the other, then the proportionality between the current and the flux produced thereby becomes altered, so that $Ia\ \phi b$ no longer equals $Ib\ \phi a$, and the resultant torque assumes a value proportional to their difference. A change in the relative reluctance in the two directions may be obtained by removing a portion of the core material in one axial brush line, thereby retaining the projecting poles common in direct-current practice.

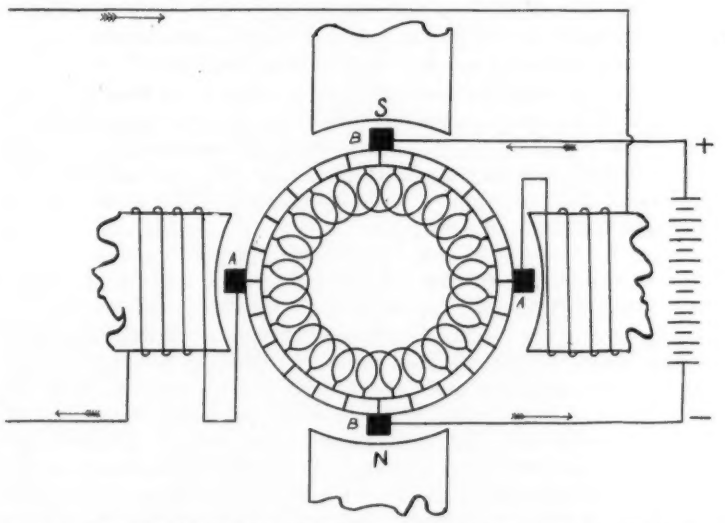


FIG. 2.—SUPERPOSED DIRECT CURRENTS IN ARMATURE. ONE QUADRATURE FIELD NEUTRALIZED. GOOD OPERATING TORQUE.

Fig. 2 shows a method by which the flux, which current through the brushes $A\,A$ would tend to produce, may be rendered of zero value for any amount of current in the circuit, thus giving the effect of infinite reluctance in this axial brush line. When the effective turns on the stator core are equal in number to those on the armature, with circuits connected as here indicated, the machine will operate as a separately excited direct-current motor. The torque will be of a value determined wholly by the product of the current through $A\,A$ and the flux along $B\,B$, and will be in no wise influenced by the fact that the flux is produced by current in the armature. The statement here made easily admits of experimental verification.

While the facts presented above are more of theoretical interest than of practical importance with reference to direct-current machinery, they form the essential groundwork upon which are based the fundamental equations for determining the characteristics of numerous types of alternating-current commutator motors, now being developed.

Storm Damage to Electric Wires.

The damage to telegraph wires in Maine by the recent storm was heavy. It is estimated that 10,000 miles of wire were down in that one State. Much of the wire was so badly entangled that it was impossible to reuse it. It is calculated that the total damage to electrical wires in the State amounted to over $500,000.

On the Experimental Determination of the E. M. F. of Dispersion of Stray Field of an Armature Winding.

BY C. F. GUILBERT.

IN various studies of the armature reaction of an alternator, we have shown all the importance of determining the e.m.f. of dispersion of the armature with the greatest exactness when it is wished to predetermine, by calculation, the load characteristics with low power factor.

This determination can be made experimentally, as we have recently pointed out, with the aid of two test coils connected in series, and wound—the one, turn by turn with one of the armature coils, and the other in the reverse direction to the first—within the same slots, near to the entrefer, and, if possible, even within it.

Our intention is to prove that, in order to obtain the real value of the e.m.f. of dispersion, it is necessary to use these two coils; but that, on the other hand, this combination can be applied to all possible conditions of operation; that is to say, any condition, from short-circuit to full load.

For greater simplicity we will consider the case of a single-phase alternator with coils in rectangular slots—that of a polyphase machine with any kind of armature teeth being easily deduced therefrom, as we shall, however, demonstrate.

DETERMINATION BY OPERATION ON SHORT-CIRCUIT.

The most convenient method of obtaining the e.m.f. of dispersion with any degree of exactness, if the teeth of the armature are not over-saturated under load, is to operate the alternator on short-circuit. Let us estimate the flux passing through the entrefer into the armature in this operation.

This flux will comprise:

1. The stray flux of the armature across the space $A\,B\,C\,D$ (Fig. 1), situated below the layer nearest to the entrefer.

2. The stray flux across the space occupied by the conductors themselves.

3. The flux traversing the magnetic circuit common to the armature and the field magnet.

These two latter fluxes being the only ones which pass through the armature coil when short-circuited, will produce in this coil an induced e.m.f. equal to the ohmic drop.

If the first test coil is placed near the entrefer, for example, with one of its sides in $A\,B$ (Fig. 1), it will be noticed that the three fluxes which we have just mentioned pass through this coil. Let us estimate the value of these different fluxes, using the notation of Fig. 1. The distribution of ampere-turns at each point of the parallel faces of the slot may be represented by a right-angled triangle, $F\,G\,D$; that of the induction in the different horizontal tubes of force crossing the slot may be represented by the same triangle terminated by a rectangle.

The flux passing through the part $A\,B\,C\,D$ has evidently the value

$$0.4\,\pi\,Ni\,\frac{L\,l_1}{h},$$

N being the number of conductors in the slot and i the instantaneous strength of the current.

The mean value of the m.m.f. between the points E and C is:

$$\frac{1}{2}\,(0 + 0.4\,\pi\,Ni) = \frac{0.4\,\pi\,Ni}{2}.$$

The flux, then, in the part marked $C\,D\,E\,F$ is:

$$0.4\,\pi\,Ni\,\frac{L\,l}{2\,h}.$$

If ϕ represents that portion of the flux which passes through all the turns of the armature coil, the flux passing through the test coil, $A\,B$, will be

$$0.4\,\pi\,Ni\left(\frac{l_1}{h} + \frac{l}{2h}\right) + \phi,$$

and the e.m.f. corresponding to the N turns of this will have the value:

$$e = -\,0.4\,\pi\,N^2\left(\frac{l_1}{h} + \frac{l}{2h}\right) - N\,\frac{d\,\phi}{d\,t}.$$

It is well to note that, on open circuit, with the same total flux emanating from the entrefer, one would have evidently an e.m.f. equal to e in the coil considered as an armature, since the difference of magnetic potential between the faces opposite each slot being inappreciable, there would be no appreciable flux between $A\,B$ and $E\,F$.

This formula shows that the first test coil considered does not give the desired value of the e.m.f. of dispersion, but a greater quantity, exactly that of the fall of tension, $r\,i$, which includes not only the second term, but a part of the first. Let us calculate now the value of the e.m.f., e, actually excited on short-circuit in the armature coil and consequently in a second auxiliary coil, wound turn by turn with the latter, which naturally is reduced to $r\,i$.

Let X (Fig. 2) represent the distance between the deepest layer and that containing a definite conductor of which we will estimate the e.m.f. which is induced in it.

The conductor is evidently surrounded only by the stray flux included in the portion, $E\,F\,H\,K$, and by the flux, ϕ.

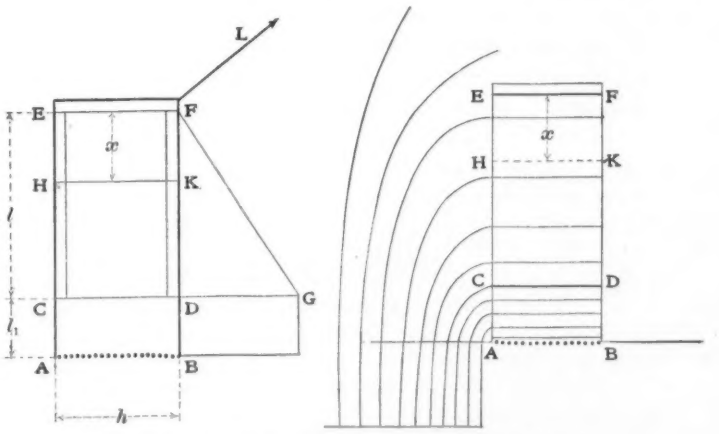
The former has evidently the value:

$$\frac{1}{2}\left(0 + 0.4\,\pi\,Ni\,\frac{x}{l}\right)\frac{L\,x}{h}.$$

The e.m.f. in the conductor, and its homologue in the second slot of the coil is then

$$-\,0.4\,\pi\,N\,\frac{L\,x^2}{2\,l\,h}\,.\,\frac{d\,i}{d\,t} - N\,\frac{d\,\phi}{d\,t}.$$

If we consider the turns situated in a layer of infinitely small



FIGS. 1 AND 2.—STRAY FIELD EXPERIMENTS.

thickness, $d\,x$, and which are consequently for that layer of the number of $d\,x$, the e.m.f. actually induced will be

$$-\left(0.4\,\pi\,N\,\frac{L\,x^2}{2\,l\,h}\,.\,\frac{d\,i}{d\,t} + \frac{d\,\phi}{d\,t}\right)\frac{N}{l}\,d\,x,$$

which gives for the complete coil by integrating between the values 0 and x of the variable, X:

$$e_1 = -\,0.4\,\pi\,N^2\,\frac{L}{2\,l^2 h}\,\frac{d\,i}{d\,t}\int_0^l x^2\,d\,x - \frac{N}{l}\,\frac{d\,\phi}{d\,t}\int_0^l d\,x,$$

$$= -\,0.4\,\pi\,N^2\,\frac{L\,l}{6\,h}\,\frac{d\,i}{d\,t} - N\,\frac{d\,\phi}{d\,t}.$$

If we subtract this e.m.f. from that obtained in the first auxiliary coil, $A\,B$, we have

$$e - e_1 = -\,0.4\,\pi\,N^2 L\left(\frac{l_1}{h} + \frac{l}{2\,h} - \frac{l}{6\,h}\right)\frac{d\,i}{d\,t},$$

$$= -\,0.4\,\pi\,N^2 L\left(\frac{l_1}{h} - \frac{l}{3\,h}\right)\frac{d\,i}{d\,t},$$

of which expression the effective value is:

$$E - E_1 = 2\,\pi\,f \times 0.4\,\pi\,N^2\,L\,I\left(\frac{l_1}{h} + \frac{l}{3\,h}\right)10^{-8},$$

I being the effective real strength of the short-circuit current. Here we recognize at once the formula of Arnold applied to the case of a rectangular slot.

The combination of two auxiliary coils connected in series, after the inversion of the direction of winding of one of them, gives the value of the e.m.f. of dispersion sought.*

The use of two test coils connected in series is then indispensable to obtain the correct e.m.f. of dispersion.

It is self-evident that one can take as the number of windings of each of them a multiple of the number of windings of the armature coil under consideration.

In particular, with bars occupying the entire depth of the slot, there will be room to use many turns distributed uniformly over this distance.

Nevertheless, in this case, the distributing of the m.m.f. along the conductors not following a linear law, in consequence of the effect of Foucault current produced by the stray flux, the approximation obtained in the measure of the e.m.f. of dispersion will be less great.

Remark.—It is easy to show that if the alternator employed should have more than two slots per coil, the results would remain the same as in the preceding case. In fact, it is evident that the flux corresponding to the stray field through the slot windings situated between those of the largest component coil, pass through all the turns of the latter. It would, therefore, be sufficient to take account thereof in the various component coils (except the innermost) to add to the value of the flux corresponding to the stray fields of the slot windings within the component coil under consideration, that of the flux passing through all the turns of the composite armature coil considered.

As to the innermost component coil, the case is the same as that already studied.

Now, as it suffices to work out the algebraic sum of the results obtained with each component in a composite armature coil, and as the preceding calculations show that $N \frac{d\phi}{dt}$ disappears, it would be the same with every e.m.f. corresponding to a supplementary flux. The results will thus be the same and, in short, it will be necessary only to place the test coil in turn in each slot of a composite armature coil.

The preceding rule can be applied also to the different coils of a polyphase alternator over and above that considered in the preceding calculation. The latter is, in consequence, found to be applicable to polyphase machines.

DETERMINATION OF FULL-LOAD OPERATION.

When the exact value of the e.m.f. of dispersion is to be obtained, and especially when it is desired to study its variation as a function of the dephasing, it is possible to work at full load with the same arrangement as in the preceding case. In fact, the expressions of e and e_1 will be quite the same as in the first case studied, if one designates by the flux passing through all the turns, and corresponding this time to a certain difference of potential, v, at the terminals of the coil. As the e.m.f. $N \frac{d\phi}{dt}$ is eliminated in the difference of induced e.m.f's in the two test coils, so the same method is as applicable to the simple alternating-current alternators as to the polyphase alternators and with any number of slots per coil.

Thus, the arrangement recommended is theoretically well adapted to the proposed result.

In order to prove its practical application, however, there is room for some important remarks.

Remark I.—If, in consequence of a sufficiently high induction in the teeth, there are stray magnetic fluxes on open circuit across the slots, the tension will not be the same in the two test coils, as we supposed in the beginning. It will be the same with unopened perforations, the stray flux across the intervening walls passing through only the test coil situated in the entrefer opposite the armature iron. In this case the combination of the two coils will give a certain e.m.f. on open circuit for one and the same flux at full load, and it will be sufficient, in considering this practically, to subtract this e.m.f. from the e.m.f. at full load, to obtain the desired e.m.f. of dispersion. With two slots closed the test coil not wound turn by turn with an armature coil can be attached in the entrefer to the armature iron at the narrowest portion of the intervening wall between adjacent perforations.

The lines of force which will be pushed outward through this coil will be, in fact, practically negligible, in this case, especially if the coil in question is made as narrow as possible.

Remark II.—With slots more or less open, in placing the test coil in the part of the slot grooves next the entrefer and as near as possible to it, a portion of the e.m.f. of dispersion is eliminated, which corresponds to the stray flux of the armature in the entrefer.

Theoretically, this test coil ought to be placed near the field magnet at full load and against the armature on open circuit. The position against the armature being practically the only one possible, it is best to add to the results obtained experimentally the value of the e.m.f. of dispersion corresponding to that part alone; that is to say, per coil:

$$e_2 = 2\pi f \times 0.4\pi N^2 I \frac{L\delta}{2h} \times 10^{-8};$$

for example, δ being the entrefer, and N the number of turns of a complete armature coil. This expression, f or e_2, agrees above all with the values of h greater than δ.

For the lower values of h, the following easily established formula may be used:

$$e_2 = 2\pi f \times 0.4\pi N^2 I \frac{L\delta}{h + 1.5\delta} \times 10^{-8}.$$

Remark III.—Up to this point we have considered only the dispersion on the interior of the slots, so as not to complicate the calculation. Let us now examine how the preceding investigation is to be modified by the introduction of self-induction of the external parts.

It is, first of all, beyond doubt that the coil wound outside even turn by turn with an armature coil, and of which the e.m.f. really induced is reduced to ri on short circuit, will include in its components an e.m.f. corresponding to the self-induction of the external parts. If one designates by λ the coefficient of corresponding self-induction, the value of this e.m.f. of self-induction will be $+ \lambda \frac{di}{dt}$ (the $+$ sign being a suitable symbol in this case since the stray flux is, externally, directed in an opposite direction from that within the entrefer), and the new value of e would be:

$$e_1 = -0.4\pi N^2 L \frac{l}{6h} \frac{di}{dt} + \lambda \frac{di}{dt} - N \frac{d\phi}{dt}.$$

It is already evident that the second test coil cannot be wound, externally, along the external parts, since it would then contain a term practically equal to $\lambda \frac{di}{dt}$, so that the e.m.f. of external dispersion would disappear in the difference $e - e_1$. It follows, then, that the external portions of the coil near the entrefer will have to be applied against the lateral faces of the armature in such fashion as will remove them from the flux through the outer layers of the actual winding of the machine and of the coil wound turn by turn therewith.

In thus placing the test coils there is inserted the e.m.f. induced by the flux emanating from the field magnet and crossing the external parts of the normal winding, or, in other words, the mutual induction of the field magnet on the external layers of the armature, which reduces the self-induction of these parts.

Remark IV.—One can naturally imagine the substitution of the coil wound turn by turn by another more easily insulated—especially in the case of dynamos of high tension. This substitution is readily possible, as we shall see. The e.m.f. induced in the coil wound turn by turn being

$$e_1 = -0.4\pi N^2 \frac{Ll}{6h} \frac{di}{dt} + \lambda \frac{di}{dt} - N \frac{d\phi}{dt}$$

in the auxiliary coil must be induced the same e.m.f.

This formula shows that the necessity of eliminating the term $N \frac{d\phi}{dt}$ in the difference $e - e_1$ demands that the auxiliary coil intended to replace that wound turn by turn should have N turns.

The flux which ought to penetrate it outside the flux ϕ is, then:

*In the case of operation on short circuit, the coil wound turn by turn with the armature coil can be suppressed, if one desires only an approximate value of the e.m.f. of dispersion.

$$\frac{0.4\,\pi\,Ni}{2} \times \frac{L\,l}{3\,h};$$

that is to say, the third of the flux passing through the portion of the slot occupied by the conductors.

It results from this that the auxiliary coil ought to be found at such a distance from the bottom of the space of the depth of *l*, occupied by the conductors, that the surface of the triangle, *F D G*, shall be divided by a line from *D G* into two portions, in the relation of 1 to 2. The coil will then be found to be at a distance from

E equal to $\frac{l}{\sqrt{3}}$, or 0.58 *l*.

This has to do only with the internal parts of the slots; externally the new auxiliary coil would give place only to an approximate value of the stray e.m.f.; but sufficient, however.

To sum up, it is evident that our method makes it practically easy to measure the e.m.f. of dispersion of any winding whatsoever, and even to study the variations of this e.m.f. with the dephasing and the saturation of the teeth of the armature.

Rotary Engines.

BY PROF. DR. F. NIETHAMMER.

IN the article on "Turbo-Dynamos," which appeared in the ELECTRICAL WORLD AND ENGINEER March 19, 1904, the Patschke rotary engine was mentioned, but details which seem to be of interest to many engineers were not given. The table below shows the most important data for four of these machines:

Size, H.P.	Speed, r.p.m.	Length, m.m.	Breadth over all, m.m.	Height, m.m.	Weight, kg.	Price marks.
1	250-2500	285	150	185	25	750
104	250-650	1600	885	1195	2,070	12,000
1055	250-460	3400	2060	2060	14,500	71,000
7000	250-350	5000	3900	3900	100,000	300,000

The rotary compound engine of Patschke has an automatically

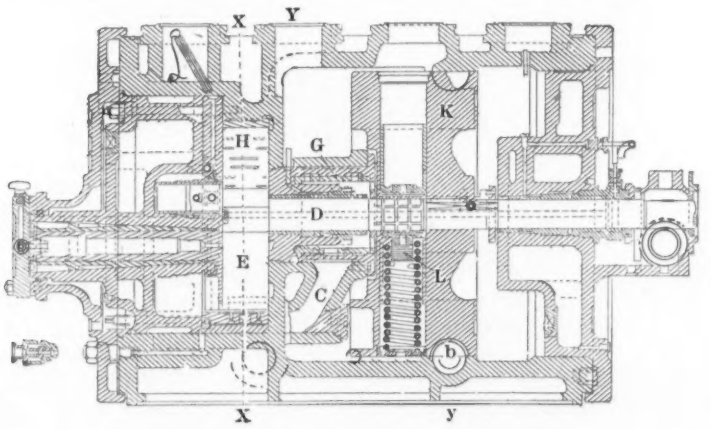


FIG. 1.—SECTION OF PATSCHKE ROTARY ENGINE.

varying grade of expansion of 0 to 80 per cent., or even to 100 per cent. Views of this engine are given in Figs. 1, 2 and 3. Before acting on the rotary piston, *H* in Figs. 1 and 2, the steam drives a turbine wheel, *K* (Fig. 1), running in the same cylinder as *H* and fastened on the same shaft, *D*. As seen in Fig. 2, the rotating piston, *H*, has the shape of a crank. The steam enters at *b* (Fig. 1) and flows by one or more nozzles, *O'* (Fig. 3), on the turbine wheel, *K*, and passes through the rotating valve, *G* (Fig. 3), to the channel, *C* (Fig. 1), and to the expansion cylinder, *E* (Fig. 1), exerting a tangential force on the crank piston surface, *H*. The shaft, *D*, transmits the useful torque, while the turbine wheel, *H*, does duty as a heavy fly-wheel. The centrifugal axle governor, *L* (Fig. 1), influences the distributing valve, *G* (Fig. 1), by two racks and pinions.

An assembly drawing of a rotary engine with double expansion in the same cylinder is given in Fig. 4, *K* being an elastic joint, *R* a special governor and *S* the receiving valve. The Patschke engine is manufactured by H. Wilhelmi, Mulheim-Ruhr, Germany. Just how many engines are in regular service could not be ascertained.

It is remarkable that Patschke, as did Rateau, combines a reciprocating steam engine with a rotating turbine, which construction

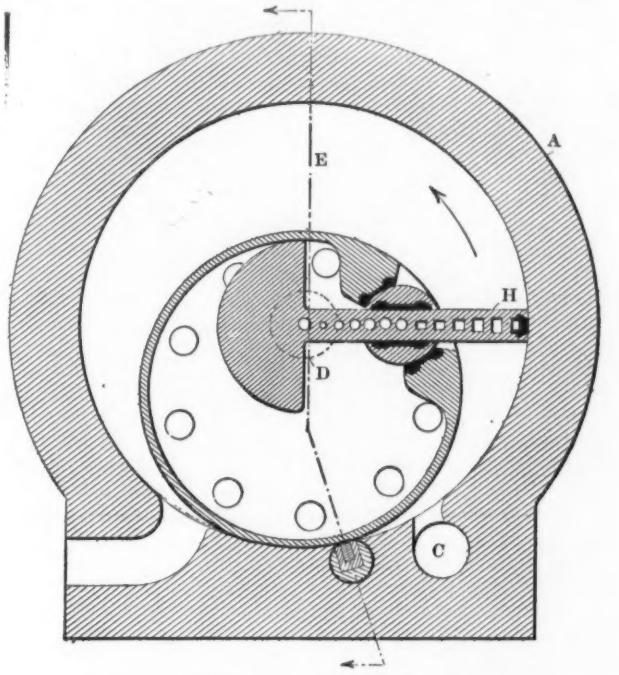


FIG. 2.—SECTION THROUGH *X X* OF FIG. 1.

enables the speed to be reduced and renders reversing and speed variation easy to obtain. This latter characteristic is specially im-

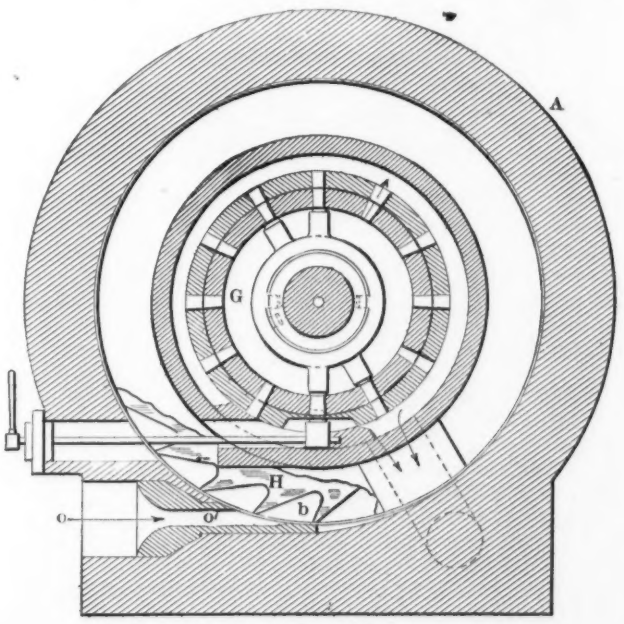


FIG. 3.—SECTION THROUGH *Y Y* OF FIG. 1.

portant for marine engines. It would seem that the rotary engine answers the requirements for such purposes, since as is well known

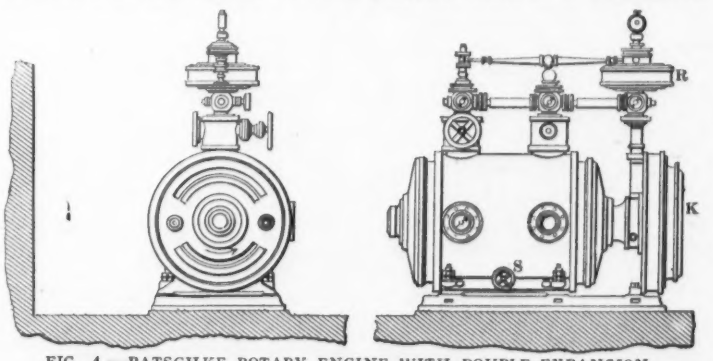


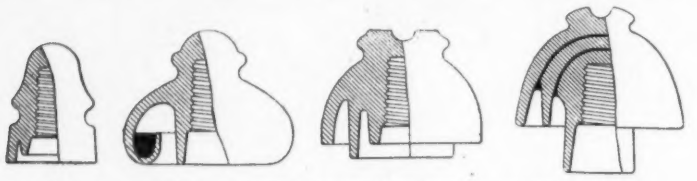
FIG. 4.—PATSCHKE ROTARY ENGINE WITH DOUBLE EXPANSION.

practical turbines for ships must necessarily be combined with reciprocating steam engines for backward movement and low speeds.

The Evolution of High-Tension Insulators.

IN a paper read before the recent International Electrical Congress, Mr. V. G. Converse gave an interesting account of the evolution of the present types of high-tension insulators. In 1890 the first alternating-current power transmission in the United States used for 3,000 volts a glass insulator of the form shown in Fig. 1. This is an insulator such as is commonly used by the telegraph companies, and is only about 3 in. in diameter. In spite of the predictions that the insulator would not suffice, the plant continued in operation for six years without insulator troubles.

For the famous Frankfort-Lauffen transmission experiments in Germany in 1891, a porcelain insulator with an oil cup was used. No definite information as to the exact shape of this insulator is at hand, but the principle was probably not unlike that of the insulator shown in Fig. 2. Voltages as high as 28,000 to 30,000 were used in these experiments for a limited time. Insulators with oil cups of various forms appeared very shortly afterward in England and the United States. If the insulator was of glass the outer petticoat was usually curved inward and up so as to form an internal groove which would hold oil. A common form for porcelain insulators was to bring down a petticoat from the body of the insulator which would dip into a cup of oil, the cup being made in a circular form and held in place around the pin by a support on the pin. Insulators with detachable oil cups were supplied for the 10,000-volt transmis-



FIGS. 1, 2, 3 AND 4.—REPRESENTATIVE TYPES OF INSULATORS, 1890 TO 1897.

sion at Pomona and San Bernardino, Cal., started in 1892. The oil cups were not used, however, as they were found to be unnecessary.

Insulators without oil cups being equally effective as those with oil cups, a form similar to that shown in Fig. 3, made of either glass or porcelain came into use. Here the idea was to impede the leakage of current over the surface by introducing petticoats which gave a very long surface between the conductor and the pin. Some insulators had as many as four or five such petticoats.

No further increase in voltage is noted until 1895, when we find the Hochfelden-Oerlikon transmission in Switzerland at 13,000 volts. In 1897 we had transmissions in the United States at 16,000 volts.

About this time it was found that porcelain insulators which had been formed and pressed in iron moulds had not a sufficiently compact or homogeneous structure and were apt to be punctured in service. A study of the matter showed that really the only effective dielectric insulation of the porcelain was contained in the glaze over the surface of the porcelain. In some cases it was found that the interior body of the porcelain insulator would actually absorb and hold a considerable quantity of water. The manufacture of porcelain was then studied with a view to overcoming these difficulties. The method was resorted to of making the insulator in several thin shells which were glazed separately and then glazed and fired together, the potter's wheel being reverted to in order to make the shells of sufficient compactness. This construction is shown in Fig. 4. It will be noted that a petticoat is here extended down for a distance over the pin for the purpose of further insulating from the pin. Attempts have been made heretofore to extend a petticoat down around the pin, but when the insulator was made in a mould no such long petticoat could be made as is now possible when the insulator is made in several parts.

In 1898 we have the first commercial very high voltage plant in operation in the United States, at Provo, Utah. This transmission is at 40,000 volts. The insulator used is of glass, shown in Fig. 5. This insulator has outwardly extending petticoats, the purpose of these petticoats being to provide unexposed surfaces near the wire in order to prevent surface leakage.

In 1900 the demands of the Bay Counties and Standard Electric Companies of California, for 60,000 volts, made necessary a very much larger insulator than had ever been made before, shown in Fig. 6. In this insulator the outer petticoat is carried out almost horizontally, and a gutter is formed on the top near the edge of the petticoat to conduct water away from the cross arm. The top piece of this insulator was originally of porcelain, and the petticoat around the pin, which now amounts to a sleeve extending down the whole length of the pin, was of glass, the glass and porcelain being secured together by sulphur at first and then cement. This type of insulator

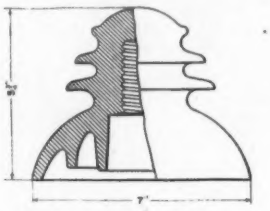


FIG. 5.—PROVO GLASS INSULATOR, 1898.

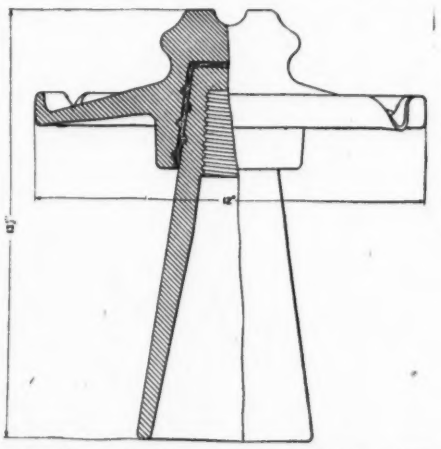
has been commonly designated the "mushroom" type, from its appearance.

A modification of the outwardly extending petticoat idea is seen in the insulator shown in Fig. 7. This form has had a limited use.

While the insulators enumerated have been referred to in order to show the successive steps in the development of the present highest-tension insulators, it must not be understood that such insulators are not still in use. On the contrary, with the exception of the oil insulator, all of these types and many others possessing the same essential characteristics, are in service, at the various voltages for which they have been found adapted. Even the telegraph insulator shown in Fig. 1 has shown good service in certain localities at voltages as high as 10,000.

Insulators of the types 3, 4, 5 and 6 are in use for voltages as high as 40,000. In various sizes these same insulators are used for all intermediate voltages up to 40,000. Types 5 and 6 are in use in a few cases at 45,000 volts. Some of these insulators have given good service from the first, while others have failed. It is believed that the failures have been largely due to faulty material. In some cases it has been necessary to replace a whole equipment of insulators because of their faulty construction; in other cases a gradual weeding out has been necessary until the faulty insulators were removed. Occasionally we hear of a plant operating where there has been almost no trouble with insulators, except with such as have been broken by outside interference. In general it is believed that the feeling exists that the line insulator problem for voltages as high as 40,000 has been satisfactorily solved.

We are now to the point of consideration of the very highest-voltage insulators—those which are in use for voltages from 50,000



FIGS. 6.—BAY COUNTIES MUSHROOM INSULATOR OF PORCELAIN AND GLASS.

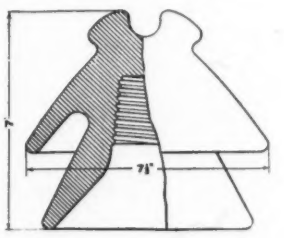
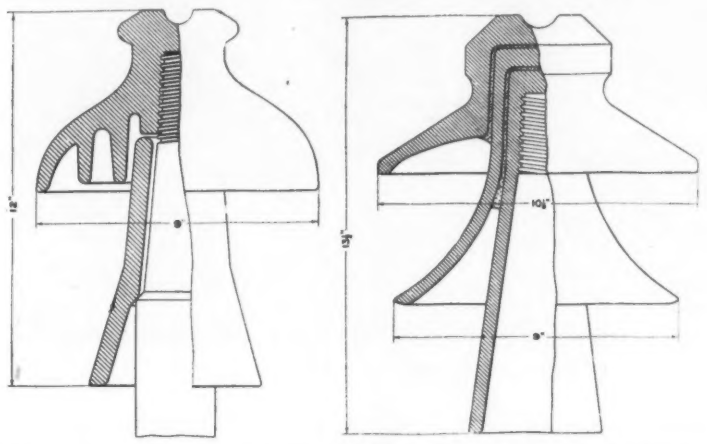


FIG. 7.—MODIFIED PETTICOAT.

to 60,000. Fig. 8 shows a glass insulator used by the Missouri River Power Company in Montana, for 55,000 volts. This insulator has been in service since 1901. The insulator is in two parts, one a hood 9 in. in diameter, and the other a sleeve set over a pin. The sleeve which is open at the top adds nothing to the dielectric strength of the insulator, its purpose being to protect the wooden pin. Obviously the sleeve would be of little value if a metal pin were used. This type of insulator possesses the advantage of being in two parts, which are separable, either of which can be replaced if broken.

The insulator used for the 50,000-volt transmission at Shawinigan Falls, Que., is shown in Fig. 9. This is of porcelain and made in

sections. Each section has a closed top and adds to the dielectric strength of the insulator. Two petticoats, one 9 in. and the other 10 in. in diameter, extend outward and give the effect of one insulator over another. One section extends down around the wooden pin and serves to protect the pin. The sections are held together with



FIGS. 8 AND 9.—MISSOURI RIVER AND SHAWINIGAN FALLS INSULATORS.

Portland cement. This insulator shows the combination of the sleeve around the pin, outwardly extending petticoats and of sections, as first indicated in Figs. 4 and 5.

Fig. 10 shows a very large and extended form of the mushroom type, which has recently been put into use on the 60,000-volt transmission at Guanajuato, Mexico. The top section is 14 in. in diameter. The sections are secured together with Portland cement, and the whole is cemented to a hollow metal pin.

For several transmissions under construction for voltages between 50,000 and 60,000, the insulator shown in Fig. 11 has been adopted. Some of these insulators exceed 14 in. in diameter and weigh as much as 25 pounds.

Abroad insulators are used which are similar to those used in this country. It is probable, however, that they have not been made in such large sizes, also that corresponding sizes are used for lower voltages.

The present highest-voltage insulators, then, of which the writer knows, and which may be considered as representing the most advanced state of the art in insulator design and construction, are represented by Figs. 8, 9, 10 and 11. Whatever advantage one may possess over the others will doubtless be shown in course of time.

Mr. Converse gave the following requirements for a high-tension insulator:

1. The material must have a high dielectric strength; in other words, it must be strong to resist puncture by the current. In order to fulfill this condition, the material must be continuous, compact and homogeneous, even the most minute crack or fracture being a weakness.

2. There must be sufficient resistance over the surface of the insulator so that there will be no considerable conduction or leakage of current.

3. The distance around the insulator between the wire and the pin or support must be sufficient to prevent the current from arcing.

4. The second and third requirements are dependent upon the shape of the insulator. Its contour must be such that there will be unexposed surfaces which will not get wet or accumulate dirt, salt, etc., as these materials are conducive to leakage and tend to lessen the arcing distance. Evidently the requirements which are dependent upon climatic conditions vary with the locality in which the insulators are to be used. If in a country which is not subjected to heavy rains, sleet or dust storms, the insulator may perhaps be smaller than an insulator required in a locality where the climatic conditions are severe. Usually a larger type of insulator is required for the same voltage in a cold country than in a warmer climate. This may explain why some insulators which have been very satisfactory under a given voltage in one locality have utterly failed when tried at the same voltage in another place. In some localities, particularly on the Pacific Coast, the accumulation of salt is so great from the so-called salt fogs that it has been found necessary to have the unexposed surfaces rather shallow and with few petticoats in order that the surfaces may be readily accessible for periodical cleaning.

5. The shape and arrangement of the petticoats should be such that the electrostatic capacity of the insulator will be small.

6. The internal heat losses from conduction and hysteresis should not be such as to appreciably heat the insulator.

7. Mechanical requirements, such as strength, mounting, method of fastening the wire, color, etc., are in general dependent upon the conditions to be met. It does not seem as if details like gutters, spouts, drip points and the like can be considered of much value. They are features which may look well in theory, but can cut but little figure in practice. Certainly the insulation of our high-voltage lines is more dependent upon a good, strong insulator with liberal margins of safety, than upon such refinements.

The following tests were advised in order to determine whether insulators will meet the requirements:

1. In order to determine dielectric strength, porcelain insulators should be inverted, with their heads dipping into salt water, the solution extending well over the head of the insulator. The hole

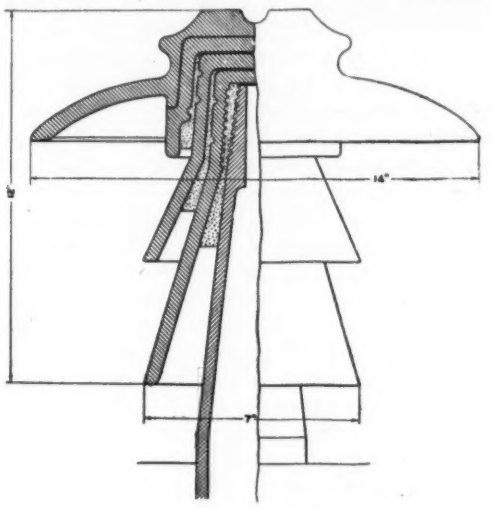


FIG. 10.—GUANAJUATO MUSHROOM TYPE.

for the pin should also be filled with salt water. The predetermined voltage for testing may then be applied to the two salt solutions. Usually a voltage test of several minutes is made. The defective insulators will be punctured in this manner. If the porcelain insulators are made in several sections, the purpose of the sections being to obtain greater dielectric strength, then the sections should be tested individually in the same way. When the sections are cemented or assembled to complete the insulator, it is advised to again test, using the same method, in order to be certain that the sections have not been broken. Every porcelain insulator of a lot should be tested in this manner.

If the insulators are of glass it is best to have every insulator

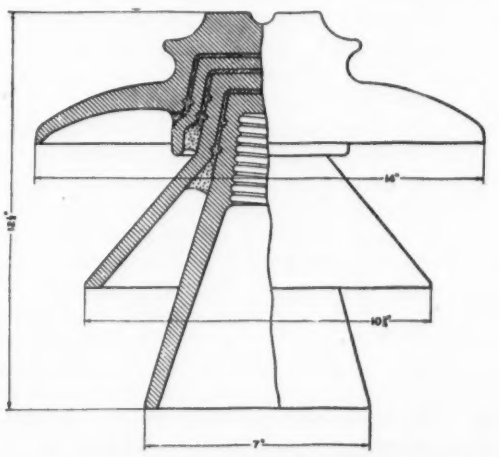


FIG. 11.—COMPOUND HIGH-TENSION INSULATOR.

tested in the manner described for porcelain insulators, but as the defects in glass are easily visible it may be only necessary to test a few of a lot in order to determine the strength of the glass, the remainder passing the rigid examination of an inspector who will discard such insulators as have cracks, air bubbles or less than the required thickness.

2. The measurement of leakage over the surface of an insulator is an extremely difficult thing to accomplish and the refined methods which are required are not applicable to factory tests of a large number of insulators. Any leakage of account will be observed in the test for dielectric strength, either by the visible creepage of the current over the surface or by the heating of the insulator.

3. A lot of insulators having passed a preliminary inspection, it is only necessary to test a few in order to meet the third requirement. These may be set up as if in service and the predetermined voltage applied. It is customary to apply the voltage to the line and pin. It is further advised that a voltage be applied across two insulators mounted in the same way, in order to duplicate as near as possible normal running conditions.

4. In order to test for the effectiveness of the contour of an insulator, it is necessary to imitate as nearly as possible the most severe climatic conditions under which the insulator is to operate. Tests of this kind have not been extended farther than to obtain the effect of a heavy driving rain. An insulator mounted as for use should have a broken spray of water thrown upon it at an angle but slightly above the horizontal. The results with this combination may then be noted with a predetermined voltage applied between line and pin, or between two insulators similarly treated.

The electrical requirements of a high-tension insulator are at variance with the requirements for mechanical strength in the following respects:

1. In order to increase the dielectric strength, reduce the capacity and lessen the brush discharges, it is necessary to increase the thickness of the head of the insulator. As the thickness is increased, the pin or support in the insulator is removed farther from the strains of the wire and mechanical stresses are brought upon the insulating material which it is incapable of withstanding. Especially is this true if the wire is tied or supported on the top of the insulator.

2. If the point of support of the wire is lowered to the side of the insulator, it is necessary that the insulator be of large diameter at the point of support in order to have the required dielectric thickness. Also with the wire on the side of the insulator, the surface distance is decreased and the length of the adjacent petticoat must be correspondingly increased.

3. No logical or safe arrangement has ever been proposed whereby all the lines of a circuit can be supported otherwise than on the tops of the insulators. In this position the surface of the insulator is exposed to the elements, at least as far as the edge of the extending petticoat adjacent to the line, and the effect is to aggravate the cause for leakage for a certain distance, where it must be checked.

4. The requirement for a larger insulator means one which is more breakable—if of glass, one apparently beyond the present knowledge of how to mould, or how to anneal.

The electrical requirements are also contradictory in this respect —a larger insulator for increasing the arcing distance adds but little resistance to leakage and probably increases the capacity.

Mr. Converse stated that he early foresaw the objections to making insulators of constantly increasing diameters for increasing voltages, and proposed the making of insulators in parts and with outwardly extending petticoats. Such construction is shown in Fig. 12. Other forms of insulators embracing the essential features have been already shown, as in Figs. 9 and 11. The purpose of the construction of the insulator shown in Fig. 12 was to study the effect of the outwardly extending petticoats in resisting arcing of the current between line and pin. The exact details of construction are a top piece, *A*, screwed onto a wooden pin, *H;* the two like sections, *B* and *C*, and a supporting section, *D*, resting on the cross arm or support, and holding *B* and *C*. *D* also serves the purpose of protecting the pin. The grooves at *e*, *f* and *g* are for holding an insulating medium, if desirable to insulate between the several parts. These parts being readily separable, it is easy to assemble *A* and *D*, or *A*, *D* and either *B* or *C*. Sections *A*, *B* and *C* were 10½ in. in diameter. Under test the terminals of the testing apparatus being connected at the point for the wire and at the cross arm, the current arced around at the following voltages, with the insulator clean and dry: *A* and *D*, 144 kilovolts; *A*, *B* and *D*, 186 kilovolts; *A*, *B*, *C* and *D*, 225.

Under a spray of water at 45° precipitation three-fourths of an inch in five minutes, the current arced at the following voltages: *A* and *D*, 118 kilovolts; *A*, *B* and *D*, 157 kilovolts; *A*, *B*, *C* and *D*, 198 kilovolts.

No insulating material was used in the grooves during these tests. There was no tendency for the current to arc between the sections, and there were no serious discharges up the inside of the sections or in the grooves between the sections. This experiment is considered of importance in that the addition of each outwardly extending petticoat section requires a nearly equal additional voltage to produce arcing. The advantage of a properly proportioned insulator with outwardly extending petticoats is, evidently, less diam-

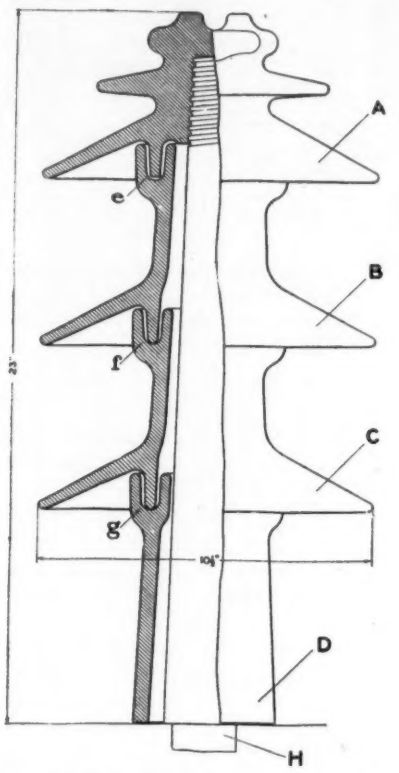


FIG. 12.—NEW HIGH-TENSION SECTIONAL INSULATOR.

eter for the same resistance to arcing around than an insulator of the mushroom type.

As to the surface conditions on insulators of glass and porcelain, no differences have been noted in the conduction or leakage of current. With high tensions, such as water or moisture as falls on the insulator is quickly dispelled or dried off by the leakage of current, high tensions tending always to keep an insulator dry. In general losses on high-tension insulators, until a brush appears, are so small that they are negligible. With the brush the losses increase very rapidly with increase in tension.

Cable and Telegraph in Central Africa.

Extensive work has been done lately in connecting the Upper Congo with the African West Coast by land lines. On the evening of October 14 a dispatch came to the French at Brazzaville, 300 miles from the sea, at Stanley Pool, that cable connections with France had been established. The next morning one of the French officers suggested that a dispatch be sent to Paris with a request that an answer be returned immediately. The dispatch was sent at 10 o'clock, and though it was delayed at several points by the necessary relays it reached Paris at 8 o'clock that evening, or ten hours after it was filed. An answer was received at Brazzaville early the next morning.

The Belgians on the other side of Stanley Pool at Leopoldville have no cable connection of their own with Europe, and they were chagrined because their old rivals on the Congo had the start of them in this respect.

When Brazzaville was connected with Europe last month the Belgians took their messages across Stanley Pool by boat to place them on the wire. They have now sent for a piece of cable to stretch across Stanley Pool between the settlements.

The French have agreed to let them connect with the land wire and as soon as the work is carried out the Belgians expect to send dispatches from Leopoldville to Brussels over the French lines. The toll is $1.75 a word.

VIEW OF ELECTRICITY BUILDING AT NIGHT.

A Review of Electricity at the St. Louis World's Fair.

BY PROF. WINDER ELWELL GOLDSBOROUGH.

IT is only fair to say that electricity has played a most important rôle in bringing about the success attained by the management of the St. Louis Exposition. The Exposition has been dependent upon electricity to a much greater extent than any previous one for the display of those utilities which serve the convenience and comfort of the public, and has as well put its dependence on electricity to provide for the public special attractions for instruction, entertainment and amusement.

Touching briefly upon these, we find that the only facilities of communication placed at the disposal of the public have been electric. They have taken the form of two very complete intercommunicating telephone systems, each having ample toll connections to both nearby and distant cities. This service has been carried out very thoroughly and completely, the number of private and public stations provided being extremely large. To this we must add the service rendered by the telegraph companies through the medium of stations well disposed in their locations about the grounds, and to which direction has been given by numerous attractive metal signs placed in conspicuous points in all of the principal buildings.

In the matter of transportation, visitors have mainly relied upon the Intramural Railway, which has given most satisfactory and reliable service, and upon the electric automobiles, which have made frequent trips over the avenues of the Exposition within the main picture. Again, the thousands of visitors who have enjoyed the trip over the canals and lagoons, from which by far the most pleasing view of the Exposition buildings has been obtained, have ridden for the most part in electric launches. In these and in many other ways electricity has served the public at every turn.

In Festival Hall, wherein has been given a most magnificent series of organ concerts, the great pipe organ, the largest ever installed, has been entirely electrically controlled in its every function, and with a perfection commanding universal admiration. In the pleasure resorts on the "Street of Nations" or "The Pike," electricity has again been the controlling factor in the best attractions. The scenic effects which have made the trip from "New York to the North Pole," "The Galveston Flood" and "Creation" so popular, and which have been so true to nature, depend entirely upon electricity. In "Creation" and "The Galveston Flood" the storm effects, and particularly the passing of storm clouds across the picture, are truly remarkable; and in the trip from "New York to the North Pole" the representation of the northern lights has been brought out in a splendid manner. The educational value of these attractions has certainly been very great, as they have been operated on a high plane, and in a manner which appeals to the higher ideals.

Not the least of the amusement features has been the naval display in which miniature battleships, cruisers and torpedo boats, electrically operated, have placed before the pubiic a most realistic exhibition of naval manœuvers. I doubt if it would be otherwise possible for anyone to obtain a concrete realization of the naval manœuvers exhibited in this show without the expenditure of a large amount of money and several years' time, as the fleets of the world do not offer the opportunities which this attraction puts forth in a way to make them available to the sightseer.

In the exhibits, which are the main object and reliance of an exposition, electricity has again, though in possibly a less conspicuous way than in the spectacular matters already referred to, played a most important part. The Louisiana Purchase Exposition before all else had for its chief object to be an exposition of processes—a demonstration of ways and means, rather than a display of products. In the early stages of the work of organization it appeared to be commonly thought by the public at large, and by the manufacturers and the exhibiting public particularly, that the idea of the working exhibit, while very attractive, would be especially difficult of realization. But where could any man go and see so many well-installed and accurately pictured working processes as at this exposition; and these processes, where not specifically electrical, have relied entirely upon electric power for their success?

In reviewing the electrical exhibits, the generating plants in Machinery Hall deserve first attention. These plants present in great detail every phase of power house arrangement, installation and operation. Generators for both direct and alternating-current power (driven by both vertical and horizontal reciprocating engines) complete with their switchboards and other auxiliary appliances, have been on exhibit in operation up to capacities of 3,200 kw. In the same way generating units driven by gas engines of wide variety and design and in working operation have also been on exhibit. But probably to engineers generally, the steam turbo-generator exhibits up to 2,000 kw capacity have been most interesting, and especially valuable in demonstrating the perfection and efficiency of these new aids to the generation of electric power. All in all, the electric exhibit of generating appliances is judged to be entirely inclusive of the best that present day practice affords.

In the Palace of Electricity, as shown so profusely in these pages, the electrical manufacturers have vied with one another in assisting the Department of Electricity in a way to promote the best results, and secure the most harmonious installation. I doubt if any visitor has had the least conception of the carloads of wire which have been placed below the floor of the Palace of Electricity by exhibitors in connecting up apparatus for the purpose of making their exhibits operative in every detail; and there are, indeed, few devices known to the electrical profession in either common or limited use, which have not been exhibited in a way to demonstrate their operative utility.

It would be tiresome here to attempt to run over the list, but it may be of value to enunciate the principle which has been steadfastly adhered to by the exhibitors, when once they realized that this and this only was the measure by which the success of their installations would be gauged. In the outset the principle laid down was that each exhibit should bring out some special feature as a working engineering installation, illustrative of some prominent phase of electrical engineering work, in a way to be directly beneficial to the visiting electrical fraternity in giving it direct insight into details of construction and operation. In one exhibit every transformer, rotary converter, motor, motor-generator, electric railway motor, controller and instrument was arranged and connected as an essential element of a working laboratory! This equipment, gauged from the standpoint of an instructional outfit, possessed a potentiality not equalled in any college laboratory known to the educational world, and its possibilities of experimentation could hardly be exhausted by any group of students within a period several times that of the duration of the Exposition. When it is remembered that this could not be

brought about without a display of fine engineering ability on the part of the designers of the installation, and a large additional expenditure of money by the exhibiting company over and above what would otherwise be necessary, to catch the public eye, the high plane on which the exhibitors in the Palace of Electricity have organized their exhibits becomes more readily apparent. This exhibit may be taken as an example of what has been done, not by a few, *but by the majority* of the exhibitors of electrical apparatus. In fact, in several instances, in order to bring out the special function performed by the apparatus they are manufacturing, exhibitors have gone to the expense of purchasing and installing associated apparatus, the value of which exceeded the cost of the apparatus exhibited; but in these special cases it has been only by the addition of this auxiliary apparatus that the prime functions of the apparatus exhibited could be demonstrated.

The newer elements which have become integral parts of the electrical industry, have been installed and exhibited on no less generous a scale than the older and more common products. It is worthy of note that there are no fewer than five systems of electric illumination which are entirely new, and which have been exhibited for the first time on a commercial scale at this Exposition. The automatic telephone has been installed and operated on a commercial scale, and given successful service in an intercommunicating system throughout the Palace of Electricity to the great interest and pleasure of the public. Each step of the process of the manufacture of the incandescent lamp has for the first time been continuously open for the inspection of the public at this Exposition. The lamp factory has employed upward of 20 operatives and had an output of several hundred lamps per day. While the incandescent lamp itself is relatively old, the processes by which it is manufactured are quite modern, not alone to the public, but to a large part of the electrical engineering fraternity.

For the first time a regular demonstration has been given daily of the results to be accomplished in alleviating deafness by the use of electromechanical vibratory apparatus, and a well-devised adaptation of the loud-speaking telephone. Probably no one exhiblt has carried with it greater interest for the public than has this in which subjects previously cut off from all communication with the outside world, have been given their first appreciation of what it means to hear. The public has, of course, shown its appreciation of the working wireless telegraph exhibits that have been so successfully carried out, and which at the close of the Exposition are in direct commercial telegraphic communication with Springfield, Chicago and Kansas City. The vigor with which those interested in wireless telegraphy have pushed the development of their system; the cordiality and heartiness with which they have co-operated with the department in its desire to establish wireless communication with outlying points at a considerable distance, should be recognized. The fact that wireless communication with Chicago was opened on Electricity Day under the auspices and test conditions which assure the accurateness of the record, has been an important factor in making Electricity Day a memorable occasion. We see then that in spirit and in fact the exhibits in the Palace of Electricity have more than met the requirements of the plan and scope of the Exposition as originally laid down, and the electrical industry is to be congratulated that it has in far-reaching and successful manner brought before the thinking and investing American public, so complete a demonstration of what can be done.

It would be unfair in this review to overlook the installation which the National Bureau of Standards has placed in the Palace of Electricity as an example demonstrative of what it is prepared to do in the way of assisting all branches of electrical engineering, whether scientific or commercial, in the work of standardizing and perfecting their products. The installation, which has at times had 20 assistants actively conducting experimental work in a model laboratory, could not be duplicated for $100,000, and it has, I feel sure, been a convincing object lesson both to American engineers and to our foreign visitors, that our Government has acted wisely in taking the step which has made the Bureau of Standards possible. To me the fact that the Palace of Electricity has been made the medium of introducing to the electrical public generally the possibilities of this laboratory, has been a source of great gratification.

Not all of the energies of those enlisted in the electrical work of the Exposition, have been confined to the organization and arrangement of exhibits and utilities. A great deal of valuable testing work has been done. This work has been accomplished under the supervision of a number of trained men assisted by a large corps of trained co-workers. The field covered has been devoted especially to electric railway work, as the electric railway now demands the larger share of our attention. The Electric Railway Test Commission appointed by the president of the Exposition has most successfully and faithfully performed the obligations imposed upon it. It is directly due to the interest taken in the work, and the energy of the members of the commission, that these tests have been carried out, and when in due course the records are published they will be most valuable and far-reaching in their effect upon future electric railway work.

The scenic pleasure of an Exposition is no longer confined to the pictures which the skill of the architect and the landscape artist are able to create upon barren fields placed in their care. We are fortunate in that electricity has made new pictures possible, and brought into being new vistas to delight and fascinate the eye. Since the Chicago Exposition the "electricity picture" has been growing, and has at the St. Louis Exposition been brought to a perfection which few would have had the courage to suggest as possible. Much training, much skill and much constant application have been required to bring about these unparalleled results, and to the engineers who have given so much of their life's work to this field, the thanks of the millions who have enjoyed these pictures are directly due. The enormous area of the Exposition grounds, as well as the great size of the buildings, has led to a presentation of architectural illumination which is in itself a great object lesson to every man who is interested in electric illumination. There are buildings which are brought into outline by electric lights in a way typical of the beginning made in this work a decade or more ago. Successive steps can be traced in a more complete outlining of other buildings by lights more perfectly following structural or architectural lines, until a stage is reached where electric light ornamentation begins, as distinguished from simpler forms. It is here that the high development of the work of the electric illumination artist becomes apparent, and blossoms out into perfect realization in the finest examples of building lighting which the Exposition affords. The interested engineer has needed nothing more than this suggestion to trace for himself the culmination of effort in this direction. To my mind artistic illumination presents the problem of painting a structure in light without reference to its architectural outline, or to a concise following of the detail of the daylight picture, providing the result shall be the realization of a beautiful conception embodying the enchantment which only the incandescent light has so far been found to give.

An important work accomplished during the Exposition relates to the awards given by the Exposition as the result of the judgments arrived at by the International Jury of Awards in judging electrical objects. The personnel of the International Jury for the Department of Electricity gave the exhibitors every confidence that the jury work would be well, consistently and thoroughly done. Among the 700 jurors who convened at the Exposition to carry out the work of judging and passing upon the merits of the exhibits, no body of men seems to have excited more favorable comment than did the electrical jurors. They attacked the problem placed before them with the utmost energy and determination. They worked long and faithfully at a difficult task, and I feel sure made a record which has been excelled by few exposition juries. Fortunately, through the co-operation of the Bureau of Standards, the jurymen were especially favored in having at hand facilities for arriving at accurate determinations of the real merits of the instruments and apparati submitted in competition. Such facilities have usually been lacking in connection with exposition work, but the satisfaction which comes with the knowledge that an award has been based upon an exact investigation, is the satisfaction which is enjoyed by the recipients of awards on electrical apparatus at this Exposition.

The work of an exposition has many phases, and to the electrical engineer and the electrical worker these are not altogether confined in the things which he finds at the Exposition, but may culminate to the highest advantage in what he himself brings. The fact that the record shows that seven of our national electrical societies have met in convention on the Exposition grounds, and have each and severally reported the results of their deliberations to be the most potent of any from their assemblages of recent years, is a record that few felt they could safely foreshadow. The fact that those in attendance upon the conventions have been so much interested as to attend the convention meetings uniformly amid all the attractions which have surrounded them in connection with the Exposition.

shows with what loyalty the electrical fraternity is seriously contemplating the problems which are given to it to solve. The result is certainly encouraging, and can be taken as a sign of the times, and points to the great virility enjoyed by our organizations.

Undoubtedly, the crowning event of the Exposition as gauged from the electrical viewpoint, was the International Electrical Congress. The spirit which pervaded the congress from the opening to the closing session had been developed in a large measure during the progress of the circular tour from Boston to St. Louis, and the success of what occurred in St. Louis must in no small part be attributed to the hearty co-operation which was extended to the congress by the electrical men in all of the cities through which the party of distinguished foreign engineers passed. It is worthy of note that the president of the Institution of Electrical Engineers, in responding on behalf of the British delegates at the opening meeting of the congress, announced in effect that to his mind the organization of the International Electrical Congress of 1904 was the most perfect of any of the congresses which had at any time been effected in relation to any subject. No more far-reaching tribute can be paid to the men who are chiefly responsible for the success of the congress than these few words of Mr. R. Kaye Gray. The congress undoubtedly accomplished an amount of work which surprised the majority of the delegates who were in attendance. It gave to these delegates a large amount of technical matter of the highest quality to digest and discuss. The congress seems, both in the work of the general sections as well as in the results accomplished by the Chamber of Official Delegates, destined to play a more important part in the development of electrical engineering than have any of the previous international congresses on electricity. The enrollment of this congress lists 2,050 members, from whom 152 papers were received. The texts of these papers with the discussions will make about 3,000 octavo pages. Thus, three volumes of 1,000 pages each, and containing the very best thought of the time on all the great electrical questions, is the record which will stand in evidence of a great work well done.

This brief review of the results accomplished by electricity at the Exposition probably does but scant justice to the actual accomplishment. No one can foretell what the direct bearing of the Exposition upon electrical development will be. The effect is more or less intangible, and yet it cannot but be far-reaching. The electrical features of the Exposition have undoubtedly stimulated greater interest in electrical undertakings, and more firmly established the place which electricity will hold among families, villages, towns and corporations throughout the world. From the reports that have come in it would seem that in a commercial way the electrical exhibitors have been fully repaid for the efforts they have made, in orders which have been taken at the Exposition; to which must be added the advantages which will come through new business connections formed.

All in all, while we must recognize that the work of bringing into successful operation a great international exposition is a most monumental task, we cannot but feel, upon maturer reflection, that such expositions are a good thing for our country in that they bring the people together, broaden their minds and enable every man to know what his neighbor is doing, as well as what he can and ought to achieve himself.

Persuasion and Pressure in Telephone Development.

The following strange story, regarding the relations of Bell and independent telephone interests in the West comes from Lima, Ohio: "Telephone men representing the independent exchanges of Central Ohio and the Central Union Company were in conference here with a view to inducing the independent exchanges in this and nearby territory to desert the United States Telephone Company and become a part of the Central Union Company. One exchange, heretofore independent, at Ottawa, has left the independent field and become interested with the Central Union. Other exchanges are said to be on the verge of taking a similar step. In the event of a refusal to join with the Central Union the latter company, it is said, is ready to open exchanges in competition with those already established. The meeting here is understood to be a forerunner of an extensive fight between independent and the older companies in Ohio and Indiana."

Tesla on the New York Subway.

The following letter appeared in the New York *Sun* of November 27, over the signature of Mr. Nikola Tesla:

My attention has been called to numerous comments on my letter, published in your issue of November 1, and relating to the electrical equipment of the newly opened catacomb in this city. Some of them are based on erroneous assumptions, which it is necessary for me to correct.

When I stated that my system was adopted, I did not mean that I originated every electrical appliance in the Subway. For instance, the one which that ill-fated electrician was repairing when he was killed, two days after the catacomb was ready for public use, was not invented by me. Nor was that other device on the side-tracked car, which, as will be remembered, caused the burning of two men. I also must deny any connection with that switch or contrivance which was responsible for the premature death of a man immediately afterward, as well as with that other, which cut short the life of his unfortunate successor. None of these funereal devices, I emphatically state, or any of the others which brought on collisions, delays and various troubles and were instrumental in the loss of arms and legs of several victims, are of my invention, nor do they form, in my opinion, necessary appurtenances of an intelligently planned scheme for the propulsion of cars. Referring to these contrivances, it is significant to read in some journals of the 8th inst. that a small firm failed because their bid was too low. This is indicative of keen competition and sharp cutting of prices, and does not seem in keeping with the munificence claimed for the Interborough Company.

I merely intended to say in my letter that my system of power transmission with three-phase generators and synchronous motor converters was adopted in the Subway, the same as on the elevated road. I devised it many years ago for the express purpose of meeting the varied wants of a general electrical distribution of light and power. It has been extensively introduced all over the world because of its great flexibility, and under such conditions of use has been found of great value. But the idea of employing in this great city's main artery, in a case presenting such rigid requirements, this flexible system, offering innumerable chances for breakdowns, accidents and injuries to life and property, is altogether too absurd to dignify it with any serious comment. Here only my multiphase system, with induction motors and closed coil armatures—apparatus unfailing in its operation and minimizing the dangers of travel—should have been installed. Nothing, not even ignorance, will prevent its ultimate adoption; and the sooner the change is made the better it will be for all concerned. Personally I have no financial or other interest in the matter, except that as a long resident of this city I would have been glad to see my inventions properly used to the advantage of the community. Under the circumstances I must forego this gratification.

The consequences of the unpardonable mistake of the Interborough Company are not confined to this first Subway or even to this city. We are driven to travel underground. The elevated road is the eighth world wonder, as colossal and imposing in the feature of public forbearance as the Pyramid of Cheops in its dimensions. Sooner or later all interurban railways must be transformed into subterranean. This will call for immense investments of capital, and if defective electrical apparatus is generally adopted the damage to life and property will be incalculable, not to speak of inconvenience to the public.

It seems proper for me to acknowledge on this occasion the painstaking suggestions of some friends of mine, mostly unknown to me, both in the large domain of electrical achievement and in the small sphere of my friendship, to again address the Am. Inst. of Elec. Engrs. It is customary with scientific men to present an original subject only once. I have done so and do not desire to depart from this established precedent. A lecture on the defects of the Subway offers great opportunities, but would not be original. In view of certain insinuations I may cite a recently published statement of Mr. C. F. Scott, formerly president of the American Institute: "As a matter of history it is the Tesla principle and the Tesla system which have been the directing factors in modern electrical engineering practice." There are but a few men whose acknowledgment of my own work I would quote. Mr. Scott is one of them, as the man whose co-operation was most efficient in bringing about the great industrial revolution through these inventions. But the suggestions of my good friends have fallen on fruitful ground, and should it be

possible for me to spare time and energy I may ask the city authorities for power to investigate the Subway and make a sworn report to them on all the defects and deficiencies I may discover, in the interest of public welfare.

A few more words in relation to the signs. With all due respect to general opinion, I entertain quite a different view on that subject. Advertising is a useful art, which is being lifted continually to a higher plane and will soon be quite respectable. It should not be hampered, but rather encouraged. I would give the Interborough Company every facility for exploiting it, restricting it only in so far as the artistic execution is concerned. A commission of capable men, comprising a painter, a sculptor, an architect, a literary man, an engineer and an executive business man might be appointed to pass upon the merits of the signs submitted for acceptance. I do not see why the public should object to them if they were regulated in this manner. They will further business, make travel less tedious and help many skillful artisans. The Subways are bound to become municipal property, and the city will then derive a revenue from them. What is most important for the safety to life and property, quickness and security of travel, should be first considered. All this depends on the electrical equipment. The engineers have built a good tunnel and proper apparatus should be installed to match it.

New Telephone Patents.

SWITCHBOARD FOR MULTIPLE SERVICE.

R. M. Eaton, of Philadelphia, has brought out a switchboard for simultaneous connection to several line systems. The idea in view is the provision not only of regular telephone service over a regular telephone line, but also information or "newspaper" service and entertainment service. The subscriber can at will signal his regular operator for exchange service as he may disconnect himself from the exchange entirely, place a busy test on his line and connect himself to the "newspaper" lines over which is to be continually furnished such information as is now given on stock tickers. By still another manipulation of his instrument the subscriber may connect himself to entertainment lines, upon which music, sermons or other entertainment may be passing. These furnish examples of the variety of services which may be tapped, but the patent has no direct limitation to them, but covers the switching apparatus only.

EXTENSION BELL RINGER.

An extension bell ringer of considerable novelty has been patented by U. W. Fouche, of Ryan, Va. This is to all intents a pole changer, the arm of which is to be driven by the hammer rod of the regular magneto bell. The effect upon the proper ringing of the main bell is not noted, but it must certainly be considerable.

CUT-OUT AND SWITCH FOR TELEPHONES.

Messrs. I. B. and C. A. Harris have jointly invented a combination cut-out and switch for telephone lines. The telephone instrument is connected to a pivoted lever, which is controlled by a cord. When the cord is slack the instrument line is connected to one of two lines. When the cord is given a moderate tension, the lever is swung out of contact with the first line and into contact with a second line. A strong tension clears the telephone line of both main lines.

ANTISEPTIC DEVICE.

A very simple antiseptic device has been patented recently by G. E. Grimm, of Collingswood, N. J. This consists of two rings of stiff paper secured on either side of a disc of tissue paper or gauze, which has been impregnated with antiseptic solution. One of the rings is so perforated that several tongues are formed, which may be snapped over a transmitter mouthpiece to hold the protector across its mouth.

MULTIPLE SWITCHBOARD FOR GROUNDED LINES.

A patent long pending has just been issued to M. G. Kellogg, of Chicago, for a compact multiple for grounded lines. Two lines are carried to each jack and the connecting plugs are reversible, so that connection may be made to either line at will. To render both lines continuously available for connection, each plug is connected to a series of extension jacks. By this means, if a plug is in a jack, the line not wanted is extended to the extension jacks available for use with any other cord pair. The signals, line and clearing out, are polarized and the selection of the proper one is left to the subscribers, a reversing key being provided at each station. The patent is assigned to the Kellogg Switchboard & Supply Company.

TOLL TRUNK SYSTEM.

In Fig. 1 is shown a rather complicated circuit for a through ringing toll trunk system. The drawing shows a calling and a called subscriber with the various connecting circuits led through positions of a trunking operator, a recording operator and a toll operator. Upon a call for toll being received by a regular subscriber's operator (not shown), she orders the connection of this subscriber to a trunk. This connection is shown by the lighting of the white lamp, *w*, in front of the recording operator. When this operator responds she transfers the signal to the green or waiting lamp, *g*. After receiving the call and writing the check this latter is passed to the toll operator, who takes up the trunk with her connecting cords. This locks out both lamps at the recording position. The toll operator has a supervisory signal and when the connection is made up she can ring through to the calling subscriber selectively or otherwise and without the assistance of the other operators. The accomplishment of the proper signals may be traced from the following description: The operation of test relay, *c*, follows the insertion of the trunk plug in subscriber's jack, *s'*, with the usual functions. The subscribers, being waiting, the relay, *n*, operates at once, relay *f* following to close the circuit of lamp *w*, at the recording position, and also closes the repeating coil circuit. The recording operator responds with key *t*, thereby through *t'*, closing the circuit of relay *p*. This relay shifts the signal circuit to the green lamp, *g*, and at the same time locks itself through contact p^2. When the toll operator plugs in relay *o* comes up, cuts off lamp *g*, puts a shunt on the signal lamp in front of the trunking operator and thus extinguishes it, and at the same time connects a shunt circuit in such a manner as to control the supervisory of the toll operator. Ringing by the toll operator operates relay *h*, which in turn closes the circuit of relay *e* to cut out the repeating coil circuit entirely and close through the trunk as a direct line. E. H. Smythe is the inventor of this system, the patent for which is assigned to the Western Electric Company.

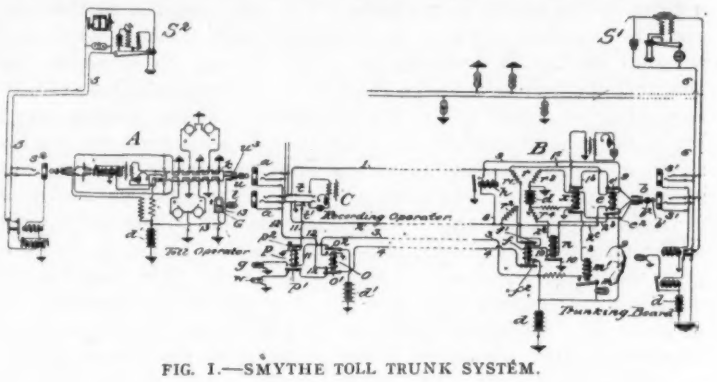


FIG. 1.—SMYTHE TOLL TRUNK SYSTEM.

BINDING POST.

H. J. Guttman, of Chicago, has patented a simple though effective form of binding post. This is made of a strip of a sheet metal formed up as shown in Fig. 2. As will be noted, provision is made for a soldered wire and a large surface clamping device for heavy wires at the left of the clamping screw, and for small wires at the

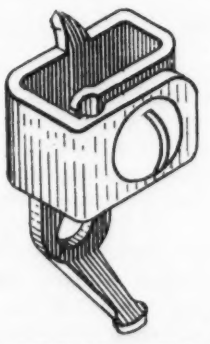


FIG. 2.—GUTTMAN BINDING POST.

right of the screw. The Automatic Electric Company has been assigned the patent for this clamp.

PARTY LINE SYSTEMS.

A step-by-step party line system has been patented by F. Vollmer, of Winsted, Minn. This comprises apparatus for the usual processes of such systems, the switching devices being synchronized by clocks at the various stations.

A second party line patent is one granted to W. E. Shackelford, of Lexington, Ga. The system herein described includes means for dividing a long party line into sections, these terminating in the particular stations involved in a connection. Thus, if statio 1 be talking to central, station 2 may call 4 and 6 may call 5, all without interference. As fast as the stations clear out the sections developed by their calls are closed through to form a through party line.

A NEW MOTOGRAPH.

Edison's electromotograph is probably familiar to all who have looked into the history of the telephone, and a curious and clumsy instrument it was compared to the Bell telephone. It had, however, the ability to produce a very loud volume of tone with even a minute current. One of its greatest disadvantages was the obscuring of the transmitter sounds by superimposed friction noises of the machine itself. To overcome this difficulty and yet to preserve the loud speaking qualities is the object of a magnetic motograph recently patented by D. W. Troy, of New York City. The principles of the instrument may be best explained by reference to Fig. 3. The dia-

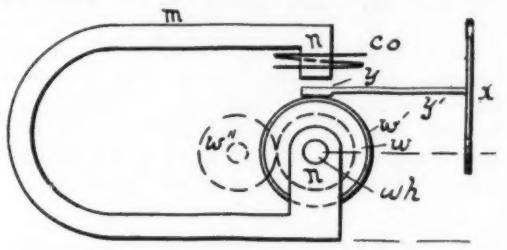


FIG. 3.—TROY MAGNETIC MOTOGRAPH.

phragm, *x*, is tied to a wiper, *y*, of magnetic material. This latter is held by magnetic attraction to bear upon the constantly and uniformly rotating cylindrical cam, *w*. This cam is of magnetic material and forms one pole of the horseshoe magnet, *m*. The diaphragm is strained until its resistance just overcomes the friction between the wiper and cam. This friction, however, is a function of the pressure at the contact, which in turn is a friction of the magnetic field and this a function of the current received in the telephone coil, *c o*. The instrument depends for its loud speaking qualities upon the circumstance that the friction varies in much greater degree than the pressure causing it.

A NEW RELAY.

Fig 4 shows a new style of relay for which a patent has been granted to H. G. Webster. The relay, as will be seen, is very similar in design of parts to many predecessors, but the arrangement of parts is novel. The black line at the right-hand end represents the edge

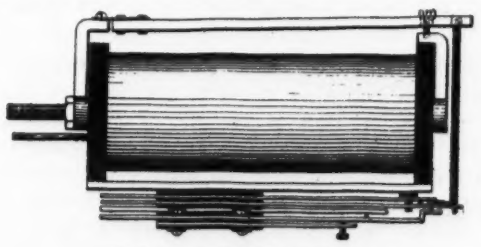


FIG. 4.—WEBSTER RELAY.

of a sheet of hard rubber which serves as a connecting plate between the armature and springs. This is held in place by the natural tension of the springs, pins upon its ends engaging respectively poles in the armature and springs. This means of fastening permits of ready removal of the plate for inspection or adjustment of the springs. The Stromberg-Carlson Company has been assigned the patent.

NOVEL CALL REGISTER.

A novel call register is that invented and patented by G. S. Nickum. This register consists of a cylindrical box containing a counter with exposed figures and certain reeds. A handle for operating both reeds and counter extends through the wall of the box, while connected with one side is a section of tube designed to be inserted between a transmitter and its mouthpiece. When a call is registered at command of the operator the sound of the reeds is transmitted to her through the regular transmitter.

NEW EXCHANGE SYSTEMS.

Mr. H. G. Webster has devised a method of controlling the signals of a common battery switchboard by the use of a differential cut-off relay, one coil of which becomes short-circuited during conversation. The short-circuited coil reduces the impedance of the regular circuit coil. Mr. Webster has developed four circuit schemes employing this arrangement, and has covered each with a patent, all these being assigned to the Stromberg-Carlson Company.

Another system employing a differential relay has been invented by K. B. Miller, the patent going to the Kellogg Company. In this system the supervising relay is differentially wound, one winding being included in each link of the cord circuit, and the display of a signal being caused by any difference in the current passing out over the two sides of the line. At first sight it might seem that such a relay would short-circuit the cord circuit, but such is not the case, as the differential arrangement cancels all inductive linkages between the two windings of the relay.

PARTY LINE SYSTEM.

A selective lock-out party line system forms the subject of a patent issued to W. H. Whithorne, of Bethlehem, Pa. The act of selection depends upon a differential relay at each station, the coils of which are balanced for one particular current combination only. When any station is desired each side of the line is given the proper current to balance the relay of the desired station, to the exclusion of all others.

ATTACHMENTS FOR TELEPHONES.

Attachments for telephones have been patented by W. M. Rashlin, of Warren, Pa., and G. W. Sebastian, of Ashland, Ky. The invention of the former is an antiseptic diaphragm and mounting for the transmitter mouthpiece. The annular mounting ring carries two bent lugs and one lug with set screw may be clamped in position by this means.

Mr. Sebastian's invention is a receiver support with attachment for operating the switchhook. The apparatus is designed for desk sets and when the support is pushed to a vertical position, out of the way, a right angle rigid arm strikes and depresses the switch lever.

Interstate Independent Telephone Convention.

As already announced in these columns, the annual convention of the Interstate Independent Telephone Association of America will be held at the Auditorium, Chicago, December 13, 14 and 15. The official programme includes the following papers: "Why Independent Telephone Securities Do Not Command the Market Price They Deserve According to Their Earning Capacity," by O. M. Bake, Hamilton, Ohio; "What the Independent Telephone Companies Owe to the Public; What the Public Owes the Independent Telephone Companies," by Theo. Thorward, South Bend, Ind.; "Manufacturers' Duties and Their Dues," by E. D. Graham, Mexico, Mo.; "Uniformity of Equipment and Standardization of Apparatus the Imperative Demand in the Operating Field," by J. H. James, Mankoto, Minn.; "The Importance of Bringing About, by Legislation or Otherwise, Uniform Telephone Rates for Exchange Service in Towns of the Same Size; also Uniform Toll Rates," by E. H. Moulton, Minneapolis, Minn.; "How to Avoid Personal Injury and Responsibility in Telephone Construction Work and Maintenance," by Senator R. C. Stephenson, Rochester, Ind.; "Where Are We? How Did We Get There? What of the Future?" by A. C. Davis, Parkersburg, W. Va.; "The Evils of Connecting With the Bell," by P. C. Holdoegel, Rockwell City, Iowa. On the night of December 15 a banquet will be held.

The association embraces over 8,000 independent exchanges and all of the independent factories and supply houses of the United States. Secretary E. M. Coleman states that the space secured for exhibits largely exceeds that of last year and the display of apparatus will be more extensive than at any previous convention. There is every indication that the meeting will be a successful one and largely attended.

Design for an Edison Medal.

A meeting of the jury in the matter of a competition for the selection of a design for an Edison medal commemorating the invention of the incandescent lamp, under the auspices of the National Sculpture Society, was held at the studio of Mr. J. Q. A. Ward, New York City, on Wednesday, November 9, 1904. Present: J. Q. A. Ward, chairman; Daniel C. French, Augustus Saint Gaudens, for the National Sculpture Society; Edward D. Adams and T. C. Martin, for the Edison Medal Association and on behalf of the American Institute of Electrical Engineers. After a further examination of the 29 designs submitted in competition the committee, by unanimous action, awarded the first prize of $1,000 for the successful design, including its execution in such shape and detail as will permit direct reduction to medal size, to Mr. James Earl Fraser. The second prize of $100 was awarded to Mr. Adolph A. Weinman and the third prize of $50 to Miss Evelyn B. Longman.

The successful competitor, Mr. Fraser, has been requested to develop his design for final consideration by the committee. It is proposed to exhibit the successful designs at the annual exhibition of the National Sculpture Society.

The Lackawanna and Electricity.

A prominent official of the Lackawanna Railroad is quoted as follows: "The rumor that the Lackawanna is contemplating in any immediate and definite way the electrification of its lines is without foundation. Most of the railroads entering New York City have a large commuter business. The proposition of electrifying these lines within the metropolitan district, which would be the zone of commuter travel, is a problem that will shortly receive very serious attention. But it is safe to say that actual work on any of the lines will more or less wait upon the results obtained by the New York Central, which is a pioneer in this undertaking.

"The Lackawanna has been installing an automatic block signal system over its lines. This year it will have been completed as far west as Elmira, N. Y., with certain short sections already done west of Elmira. The electricity for operating the block signal system is generated in the power house at intervals of thirty miles, making a delivery over a 15-mile radius.

"While the Lackawanna has not at present seriously discussed the electrification of its suburban lines, tentative figures of cost and a tentative canvass of the question in an informal way have been made. In the same way the matter has received more or less attention by all the lines entering New York City. The advances in the state of the art may be so definite and the experimental demonstration of the New York Central may be so complete that the Lackawanna might be warranted in beginning the work of electrification before the New York Central has its system in operation. Future developments, of course, may largely modify the present plans."

CURRENT NEWS AND NOTES.

INSURANCE RULES.—Secretary Dudley Farrand, of the National Electric Light Association, has notified the members with regard to the annual meeting of the Underwriters' National Electric Association to be held in New York City on December 7. A number of interesting changes and revisions of rules as to wiring, fixtures and other matters relative to electric light and power supply, that deeply affect the welfare of the central station industry, are to be considered. The National Electric Light Association, which has always followed insurance questions closely, is taking an active and vigilant interest in all that tends to perfection of methods and increase of safety.

ANOTHER OCEAN TELEPHONE.—A telegraphic dispatch from Rochester, N. Y., of November 19 says: "Prof. Howard D. Minchins, of the University of Rochester, has made a crucial test of an invention of John Dennis, of this city, to overcome line impedance in telephone service. Prof. Minchins said: 'The invention means telephoning across the ocean or from New York to San Francisco with no more difficulty than from one street to another. I have made tests of the appliance under five different grades of impedance. In each case the application of the new force was entirely successful. The new appliance is inexpensive and is entirely practical for commercial purposes.'"

NEW YORK SUBWAY TRAFFIC.—The new Subway finished its first month on November 26, having carried about 6,000,000 passengers safely. During the first twenty-nine days of its operation of the Subway the Interborough Company carried 5,838,235 passengers who have paid fare, in addition to a small number who traveled on passes and the larger number of policemen and firemen who travel free. The daily average of traffic, not counting the Lenox Avenue branch, which opened only a few days ago, was 201,318, showing daily average receipts of $10,065.90. Figures concerning the origin of traffic show that 428,318 took the cars at Fourteenth Street and 476,670 at the Grand Central Station. Brooklyn Bridge Station had, of course, the largest number of ticket purchasers, one-fifth—1,185,863—of the total local traffic having originated at that point.

ENGINEEERING BIOGRAPHY.—A very interesting and useful project has been undertaken by Mr. E. C. Brown, of New York City, publisher of the well-known technical paper, *The Progressive Age,* in the issuance of a terse biographical directory of American engineers. There is nothing of the kind extant. The proposed work, now under compilation, will embrace civil, mechanical, electrical, mining, naval and chemical engineers, and will give some 4,000 brief biographies. It will be an octavo of about 6 x 9 in., containing about 700 pages. The personal data thus given will be supplemented by a complete list arranged in one alphabet of all the engineers, some 10,000 in number, in all the national engineering societies indicated. This will be quite valuable. The method of biographical inclusion is to consider eligible all who have been active members in their respective organizations for a period of ten years.

WIRELESS FOR BERING STRAITS.—It is stated from Seattle, Wash., that cable and telegraphic communication with Siberia, the Orient and the Old World countries by way of Bering Straits is proposed by John Rosene, managing director of the Northeastern Siberian Company. He intimates that if the United States Government will extend its Nome telegraph line from Nome on to Cape Prince of Wales, and thence establish the wireless system across Bering Straits between Cape Prince of Wales and East Cape, the nearest point of the Siberian side, the intervening distance being only from twenty-eight to thirty-five miles, the Northeastern Siberian Company will build an overland telegraph line across Northeastern Siberia, for the whole of which it holds a concession from the Russian Government, to a connection with the telegraph line extending along the Trans-Siberian Railway from Vladivostok to St. Petersburg. This, by means of existing cable connections, would place Japan, China, the Philippines, Korea, Manchuria and other Far East countries, as well as the continent of Europe, in cable and telegraphic communication with all points on the North and South American continents. It could be done, Mr. Rosene insists, at a much more reasonable telegraph and cable tariff than now obtains.

CONSTANT-FREQUENCY, ASYNCHRONOUS GENERATOR.—When an induction motor is driven above the speed corresponding to synchronism it becomes a generator and returns energy to the supply system. The load which such asynchronous generator assumes depends upon the slip, or the difference between the speed of the rotor and that of the revolving field. If the rotor travels at constant speed then with increase of load the revolving field must decrease its speed, which means that the frequency must become lowered; or if the frequency is to be maintained constant, the rotor must increase its speed directly with increase of load. For the purpose of obtaining an increase of speed of the prime-mover with increase of load on the asynchronous generator, Mr. C. S. Bradley has devised a dynamometer governor for which a patent was granted November 22, 1904. Mounted upon the shaft of the rotor is a transmission dynamometer, the springs of which will be distended according to the torque exerted by the rotor, and the circumferential motion thus produced will operate the energy intake mechanism of the prime-mover in a manner to give the desired increase in speed.

ELECTRICAL RULES IN NEW YORK CITY.—At the meeting of the Board of Aldermen of New York City on November 22 an ordinance was presented and referred to a committee for report adopting, with a few changes, the National Electrical Code for the installation of electric wiring and apparatus, and making its rules mandatory within Greater New York. Among the changes is one requiring gas lighting apparatus to be insulated from fixtures. The rules as presented are printed in full in the *City Record* of November 24.

TWENTY-EIGHTH CONVENTION OF THE N. E. L. A.—President Davis, of the National Electric Light Association, has just returned from a trip to Colorado, where he went for the purpose of deciding upon the meeting place of the twenty-eighth convention of the association. After visiting Denver and Colorado Springs and conferring with a number of Western members, it was decided that the business meetings of the convention be held in Denver for three days and the delegates then be taken to Colorado Springs for the entertainment portion of the meeting, giving two or three days to sightseeing and social intercourse. The meeting will be known as the Denver-Colorado Springs convention.

MUNICIPAL OWNERSHIP.—A report from the United States Consul at Liverpool states that there is an unmistakable cessation in Great Britain of the tendency toward the municipalization of industries. Very little is heard now of new movements in that direction and the thoughts of the municipalities are more directed toward increasing economy of management of the public utilities which have been acquired. Probably the reaction against the municipalization of industries is due to the fact that there has been an increase of $1,252,000,000 in local indebtedness in the United Kingdom in 28 years, that rates for borrowing money have become more severe, and that the return over the whole mass of municipal investment has not been anything like as high as was expected.

THE PORTLAND EXPOSITION.—So great is the demand for space at the Lewis and Clark fair at Portland, Ore., that the present Foreign Exhibits Building and the Liberal Arts Building are found to be entirely inadequate, and ways and means will at once be devised to provide necessary additional space. Director of Exhibits Dosch, now in St. Louis, notwithstanding the fact that application made there for space in these buildings exceeded the ground area by thousands of feet, granted all the applications and communicated with the Lewis and Clark Corporation at Portland, which immediately approved his action. According to the exposition officials the plan will probably be to surrender the present Liberal Arts Building to the uses of foreign exhibitors, which will afford ample room for this branch of displays, and construct a Liberal Arts Building of such proportions as shall insure ample room for all domestic exhibits.

AMERICAN AUTOMOBILE SHOW.—The show of the automobile industry in Madison Square Garden next January promises already to be most successful. With less than half a dozen importers of foreign machines among the exhibitors, all the available space has been taken, and several of the late applications had to be refused. The galleries of the building will be occupied to as great an extent as last year, the smaller exhibits of automobile parts being placed there. Nearly 100 automobile manufacturing companies will be represented by complete machines and over half of these will have space on the main floor, others being in the restaurant room and on the platform to be erected over the boxes. In all there will be over 250 exhibitors. This assures the financial success of the exhibition, and the Automobile Club of America and the National Association of Automobile Manufacturers will jointly manage the event. Each of these organizations received from last year's show about $13,000. The Madison Square Garden show will open Saturday night, January 14, and will close on the night of January 21. The foreign cars will be exhibited in Herald Square Hall, and this exhibit will open on Wednesday night, January 11, and close on January 24. Nineteen different makes of foreign automobiles, including French, English and German, will be seen in this first foreign show.

A NOVEL COMMUTATOR MOTOR.—As a means for dispensing with one-half of the brushes necessary with the ordinary type of alternating-current commutator motors, Mr. Ernst J. Berg, according to a patent issued November 22, 1904, would employ compensating coils for obtaining the neutral e.m.f. point of the armature winding, as is done with three-wire rotary converters, and use this point, grounded to the shaft, for completing the circuit through the armature by way of the one brush bearing upon the commutator. A motor thus constructed possesses characteristics which differentiate it from the familiar commutator machines. At starting, when the frequency of the rotor currents is the same as the line frequency, each of the two compensators used offers a high impedance to the flow of current in the same direction through both parts, so that the effect of the compensators as short-circuits may be neglected. The motor, therefore, starts exactly like an ordinary series motor with two sets of brushes, and possesses the high starting torque of the series machine. As the rotor speed approaches synchronism, however, the frequency of the rotor currents diminishes and the impedance offered by each compensator to current flow of the same direction in both its parts diminishes, so that the compensators begin to assume the character of short-circuits. Consequently, near synchronism, the motor possesses certain of the characteristics of the induction motor superposed upon those of the series motor, and the motor will not increase its speed indefinitely with decrease of load.

LETTER TO THE EDITORS.

The Relative Reliability of Wireless and Wire Telegraph Systems.

To the Editors of Electrical World and Engineer:

SIRS:—In your issue of November 14, 1903, I contributed an article in which I pointed out that experience had shown that wireless stations were much more reliable than wire stations. In this article I referred to a number of occasions in which all communications had been cut off with wire lines, while our wireless stations had been absolutely unaffected.

The storm of last week was a very good illustration of this fact and showed again conclusively that where reliability is desired wireless communication is the only system for use. Communication was interrupted over a large area of country and I have been informed that in order to get communication between New York and Chicago it was necessary to send all around the world.

As one result of the storm all communication by wire was cut off between Washington and New York, and it was some time before the wires were repaired. So far as wire telegraph and telephones are concerned the capital of this country was as entirely isolated as if there was no such thing as a wire telegraph and telephone.

During all this time, however, our wireless telegraph stations at Washington, Philadelphia and New York were absolutely unaffected and communication was maintained with as much ease as if it were a calm summer day. Communication was also maintained to Annapolis, as the company happened to be operating a new type of army field set between Annapolis and Washington.

The writer was absent in New York at this time, but the manager of the company, Mr. Glaubitz, offered to handle business for the Postal Telegraph and Western Union Companies until their lines could be repaired between Washington and Philadelphia and Washington and Annapolis.

It so happened that I had especial reason to appreciate the advantages which wireless telegraphy have over wire telegraphy in regard to reliability, because I was in New York during the time in connection with a lawsuit and several important business matters came up in connection with some apparatus which we were installing for the United States Navy and considerable delay would have occurred had it not been for the fact that the wireless stations were working all right. The whole matter was handled by wireless telegraphy and settled up in a few hours to the satisfaction of all concerned.

This freedom from disturbance is especially interesting on account of the fact that the Washington station is very unfavorably located. It is situated in a boiler yard and on the opposite side of the city from Philadelphia, so that the waves have to pass over between three and four miles of city buildings, including the United States Capitol. The Philadelphia station is 140 miles from Washington. The attached communications will add point to and confirm the statements made in the editorial in your recent issue.

It may be definitely stated that the time is now past when a blizzard can cut off a city from all outside communication. At the present time this company is able to maintain communication between Washington and Newport, R. I., and within a couple of months it

will be possible to transmit a wireless message from Washington to Albany via Boston.

I might add that the speed of transmission between Washington and Philadelphia is the same as that of wire lines, i. e., from 20 to 35 words per minute, and that the reply to a message sent out from our factory in Washington to a party in New York City has been received in 17 minutes, in spite of the fact that no attempt was made to get quick transmission and in spite of the fact that the New York party had to be called up by telephone.

National Electric Signaling Company.

WASHINGTON, D. C. REGINALD A. FESSENDEN,

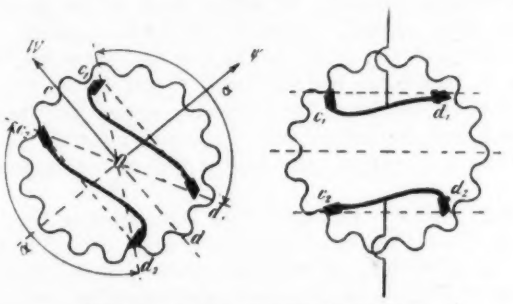
[The enclosures referred to are an affidavit made by Mr. H. J. Glaubitz, manager of the National Signaling Company, deposing that the wireless service between the company's stations at New York, Philadelphia, Washington and Annapolis was not interrupted by the storms between November 12 and 16, and that offers during this period had been made to the Western Union and Postal Telegraph Companies to handle business for them between Washington and these points; and an affidavit from I. A. Isbell, in charge of the Washington station, deposing that the storm had no effect upon the company's stations at New York, Philadelphia, Washington and Annapolis.—EDS.]

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Polyphase Induction Motors.—LAMME.—In the conclusion of his article he deals first with speed variation of polyphase motors. He discusses the following six methods: First, varying the number of poles; this is efficient to a certain extent, but is limited in the number of combinations of poles obtainable. But if combined with some of the other methods, it may be made fairly effective over a wide range. Second, varying the number of alternations; this is theoretically limited to a few special applications, for we have as yet no commercial alternation transformer. Third, motors in tandem or series-parallel; this method always requires at least two motors, where two working speeds are obtained; its application is limited to a few special cases. Fourth, secondary, with only a single circuit closed; this will give a half speed, and with two or more circuits closed will give full speed. But the power factor at the half speed is very low, and the efficiency is not nearly so good as when run at full speed. This may have a few special applications. Fifth, varying the resistance of the secondary; this will not give constant speed except with constant load, as the speed torque curve with a relatively large resistance is a falling curve. At heavy torques the motor will run at very low speeds, while with light loads it will run at almost full speed. The speed regulation will be similar to that of a direct-current shunt motor, with a resistance in circuit with the armature. To hold constant speed with variable load, this resistance requires continual adjustment. Sixth, varying primary voltage; this gives the same results as the fifth method, as the speed torque curves are similar. To hold a constant low speed, the e.m.f. must be varied continually if the load is changing. Like the fifth method, it is not efficient at low speeds, the reduction in speed is obtained by means of a corresponding loss of energy in the secondary circuits. For crane work, hoisting, etc., where it is necessary to run at reduced speed for but a portion of the time, either of the methods, five or six, is satisfactory, but method five requires the use of a variable secondary resistance, and there must be a set of secondary leads carried out to a rheostat if the speed changes are to be gradual. This introduces complication, especially on a crane where several motors are to be controlled. In this case there must be trolley wires for both the primary and secondary circuits of each motor. But by method six the control is effected in the primary circuit, and only primary trolley wires are needed, and these may be controlled from one pair of transformers. The sixth method is, therefore, the simplest and most practical one to use for hoisting, etc., and will be found to present many advantages for all classes of work, whether speed regulation is important or not. The author finally discusses the methods of varying the e.m.f. This may be done by three methods. First, varying the e.m.f. from the generator, which is possible in several ways. Second, the e.m.f. may be varied by means of transformers; either the transformers may be so connected that two or more em.f's may be obtained, or auto-transformers with loops brought out for lower e.m.f's. Third, the motor connections may be varied in order to vary the number of turns in series with a given e.m.f. Finally, it is possible to insert choking coils or resistances in the primary.—*Elec. Club Jour.*, November.

Repulsion Motor.—LATOUR.—In a former article the author has given the theory of the repulsion motor, the rotor winding of which is completely short-circuited. In reality that form of the repulsion motor which is specially interesting with respect to commutation at starting is of the form shown in Fig. 1, in which the rotor is short-circuited by means of two sets of brushes, $c_1 d_1$ and $c_2 d_2$. This



FIGS. 1 AND 2.—REPULSION MOTOR.

method must be used in motors of larger capacity if one wants to avoid the prevention of sparks at starting by means of special artificial devices. The author shows that this method does not cause greater heating of the copper winding of the rotor. With this method it is possible to compensate the motor without special brushes, by introducing the exciting current between c_1 and d_1 and c_2 and d_2, as shown in Fig. 2.—*Elek. Zeit.*, November 10.

Induction Motors.—BACHE-WIIG.—An illustrated article on induction motors built by a German company. The characteristic feature is that the pole pitch is greater than the iron length, so that the machines have a large iron diameter compared with the breadth. Although this choice of the dimensions results in general in a smaller overload capacity, yet it is possible to build the motor sufficiently strong for all practical cases with a better power factor than with greater iron length and with the same active weights. This is possible by a stronger utilization of the material, on account of the larger cooling surfaces, without using artificial cooling. In cases in which high starting torque or instantaneous overload capacity is more important than a high power factor—for instance, in crane and elevator motors—the result can be accomplished simply by less windings in the stator. The author gives the dimensions and results of tests of three motors of this type, of 250, 25 and 0.25 hp, respectively. —*Zeit. f. Elek.*, November 6.

REFERENCE.

Alternating-Current Diagrams.—KARAPETOFF.—In a continuation of his serial on applications of alternating-current diagrams, he deals with the magnetic fluxes in an induction motor. He describes the addition of the primary and the secondary flux, distinguishes between useful and leakage flux and gives the three parallelograms of fluxes.—*Elec. Club Jour.*, November.

LIGHTS AND LIGHTING.

Free Lamps.—The conclusion of the very long discussion which has been going on in the columns of this paper for some time, with

respect to the following three proposals: The periodical renewal of consumers' lamps free or on easy terms; the periodical inspection of consumers' lamps *in situ*, or the free testing of, and reporting on, consumers' lamps. T. P. Wilmshurst, who had made these proposals, sums up the discussion and replies to the criticisms preferred. Over 100 station engineers, lamp makers and others have recorded their views, and there is a striking unanimity of opinion that the day for leaving the consumer and his lamps severely alone has gone by, and that the organization of an intelligence department is essential. The discussion dealt mainly with the question whether the supervision and supply of lamps should be undertaken by the supply engineer or the contractor. Several correspondents have objected to municipal trading and do not care to take the sale of lamps out of the private trader's hand. To these Wilmshurst replies that the present unsatisfactory position is the result of leaving the field in the hands of private enterprise. If the private trader had made the larger question of the supervision of the consumer's installation his business instead of simply the sale of lamps of unknown efficiency, the present state of affairs would not have arisen. The question of free lamps was thrown out as a tentative suggestion only; the discussion shows that in the opinion of the majority the time is not ripe for the adoption of such a scheme. The free testing of lamps meets with no opposition, and Wilmshurst is convinced that in conjunction with diligent and judicious advertisement, and by circularizing one's consumers pointing out the difference in economy between, say, a 3½ and a 4½-watt lamp, the utility of a testing department will be abundantly justified. Snell will shortly put into force a scheme for the up-keep of both ordinary and Nernst lamps. Boydon suggests to use lower voltage lamps in series and overrun them, say, three 70-volt lamps on a 220-volt network, but Wilmshurst fears difficulties in practice. To do this would necessitate lamps being wired in groups of three, and when single lights were required the full voltage would have to be used. Lamps of two voltages would be required. Shawfield suggests that the municipality should purchase lamps at wholesale prices and retail to local contractors at such a price as to leave the latter a fair profit. Editorially the following remarks are made: "Mr. Wilmshurst indicates his conviction that the inspection and testing of lamps if it comes at all will come to stay. He cites the analogy of the gas companies, who are beginning now in their old age to educate their customers, and he speaks of the day having gone by for leaving the customer and his lamps severely alone. It seems that if at any time the consumer required to be educated in the choice and management of his lamps, particularly in the economy of smashing them, it would be when he first began to use the electric light, and that when it becomes the usual thing he will know all he wants to know about 'lamp efficiencies' just as he is accustomed to acquaint himself with any other detail of domestic economy. At present he is in the schoolboy stage, and must have knowledge thrust upon him. Certainly his education should not be left to the private trader or lamp contractor, who has no special inducement to undertake it. On the objections to the sale of lamps by the supply department, Mr. Wilmshurst touches very lightly. The suggestion of a municipal showroom of electrical apparatus is a good one, if only the public can be induced to frequent the exhibition."—*Elec. Age,* November 3.

REFERENCE.

Dimmer for Theatre Lighting.—An illustrated article on a new dimmer, the novel feature of which appears to be the construction of the resistances which are made out of a single jointless ribbon of metal wound into as many coils as the number of graduations of brilliancy that are required (for instance, 50). Every turn of these coils is insulated with flake mica, and the whole series of them is arranged between mica discs, which are encased between pressed steel plates by means of a single jointless band. The ribbon, which is in some cases as much as 50 ft. long, is continuously tapered from end to end and varies the light by quite imperceptible graduations.—Lond. *Elec.,* November 11.

POWER.

Electricity in Mines.—An illustrated account of the use of electric power at Slope No. 3, Pratt Mine of the Tennessee Coal, Iron & Railroad Company, at Ensley, Ala. Slope No. 3 was opened in 1886. The first haulage was, of necessity, a rather crude one and was replaced several years ago by an endless-rope arrangement with a daily capacity of 1,100 tons. It was later seen that the territory available more than guaranteed returns for the expenditure of a sufficient sum to install a haulage system, combining the most modern and efficient use of steam and electricity—capable of delivering 2,400 tons into railroad cars in a day of 9 hours' work—and this at a much less cost per ton than under the best possible arrangement of the endless-rope plan. Four six-ton and two ten-ton mine locomotives are employed in the mine to gather coal and deliver it in mine cars to the bottom of the haulage, where ample track facilities are provided for the collection of 20-car trips, in such manner that when a trip of empties reaches the bottom it is quickly passed into the mine proper and the loaded trip attached to the rope, the change requiring much less time than a minute. Each of the motors is easily capable of delivering 12 trips of 20 cars each to the chain in a day's work—each mine car holding 3,300 pounds of coal. Under the old system 35 mules with a driver for each animal and a large number of chainers to attach the cars to the rope, were employed. The use of motors dispenses with these mules and the labor mentioned—the only labor required now being a motorman for each locomotive and two or three trip riders. The electric power for the operation of the motors in the mine is supplied by three 150-kw generators located in the power house department of the building containing the hoisting engine. The trolley wires in the mine proper are suspended from the roof by means of hangers, etc., set into the solid rock. The generators also furnish power for the operation of an electric charging larry which carries the coal from the washers alongside the tipple to the battery of ovens. This electric larry takes the place of two small dinkey locomotives heretofore employed. A regulation trolley wire is used, suspended from curved iron posts made of 3-in. pipe. Four electrically-driven, triplex, double-acting geared mine pumps have been put in operation, the larger ones with 8-in. plungers having a capacity of lifting 700 gallons per minute a vertical distance of 500 ft. "Electrically-driven mine pumps are a decidedly new innovation in southern coal mines and their work, as compared with the steam pumps they have replaced, is very gratifying to the officials of the company—especially from an economical standpoint." "It is safe to assume that the first step having been so successfully taken, the use of electricity and more modern haulage systems in southern coal mines will quickly follow."—*Mines and Minerals,* November.

Combustion and Stoking.—LODGE.—A note on a lecture delivered at Birmingham University. After dealing with fuels and their calorific value, the author said that insufficient air and imperfect admixture of air are the cause of smoke. A great many open fires are inefficient because they are largely supplied with air already burned. The proper way of burning coal is to burn the lighter hydrocarbons only and to collect the heavier hydrocarbons as by-products. Referring to water-tube boilers, he said that in most cases in which they have been unsuccessful it was because the comparatively cold surface of the tubes caused them to be covered with soot or surrounded by a layer of non-ignited and non-radiating gas, which prevents the flame coming into contact with the surface. The formation of this gaseous envelope is one of the chief defects in the ordinary Lancashire or Cornish boiler, and hence the attempts to bring only the hot gases against the heating surfaces. The author emphasized the importance of having an incandescent body within the furnace, and illustrated his point by showing that the radiation from a gas jet was greatly increased when a spiral of iron wire was placed in it and heated to redness. It was in this direction that improvements in boiler furnaces would have to be sought. He concluded by saying that so long as water had to be heated by solid fuel, stoking would be a fine art, and would have to be performed by men with brains.—Lond. *Elec.,* November 11.

TRACTION.

Cost and Maintenance of Tramway Car Wheels and Rails.—BANISTER.—An abstract of a paper read before the British Association of Tramway and Light Railway Officials. The author pointed out that the flanges of iron wheels are usually considerably chipped, especially on rails with narrow grooves and where there are many points. Steel-tired wheels he has found in practice to be cheaper by 13.2 cents per 1,000 miles than iron wheels, the latter costing about 42 cents per 1,000 miles. Every wheel was calipered once per fortnight, and ground when the difference between two wheels on a car was more than 1/16 in. The average mileage of chilled wheels is 19,000 miles. The radius of curves leading to and from points should be

as large as possible, even if this entails a sharp curve later on, as it is cheaper to replace rail on the curves than to replace points. He does not think there is any rule regarding corrugation. It occurs on the Norwich system, on up and down grades and on straights and curves. They ground the corrugations down by fastening carborundum blocks in the slipper brake blocks on a spare car and simply ran the car backward and forward all night. Most of the speakers in the discussion favored steel-tired wheels.—Lond. *Elec.*, November 4.

Leeds Tramway System.—An article on the opening of the Leeds, Wakefield & West Riding tramway system. Eventually there will be some 75 miles of single track, linking together some of the most populous districts in the West Riding of Yorkshire. On all parts of the system a frequent service of cars will be maintained. The main station is situated at Belle Isle and contains three steam-driven alternators, each of 400 kw, generating three-phase current at 6,300 volts and a frequency of 25 periods per second. There will be four rotary converter sub-stations changing the three-phase current into direct current at 500 to 550 volts. The construction of the overhead lines is for the most part carried out on the sidepole system with bracket arms and flexible suspension. The rolling stock will consist of 55 motor cars.—Lond. *Elec.*, November 11.

REFERENCE.

Electric Railway Tests.—Illustrated notes on the complete series of tests which have just been concluded by the Electric Railway Test Commission of the St. Louis Exposition, on a single-truck car. The tests included motor-heating runs with several different schedules, with hand braking and repetitions of the same with magnetic braking. During the runs the indicating instruments were read every five seconds. A series of acceleration and braking runs were also made for both types of braking. Similar tests will also be made on an interurban car.—*St. R'y Jour.*, November 17.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Combined Lighting and Refuse Destructor Plant.—A note on the municipal electric lighting plant of Stoke-upon-Trent, which was recently opened. The system of electrical supply is with three-wire, continuous current at 240 and 480 volts. The power station contains two Lancashire boilers, having a total evaporative capacity of 10,000 pounds per hour. These supply steam to two three-crank engines direct-coupled to multipolar dynamos, with an aggregate capacity of 300 kw. About 6 miles of cable have been laid, solid in wood troughing. There is a battery of 240 cells in the generating station, the capacity being 350 amp.-hours; there is also a balancer and two boosters. The refuse destructor is of the Meldrum type. The total capital expenditure up to date is stated to amount to $153,200.—Lond. *Elec.*, November 4.

REFERENCE.

Automatic Appliances.—An article discussing the value of automatic central station appliances. Where automatic machinery gives more efficient control, more ease of manipulation, more all-round economy, and as much reliability as manual labor, it may be advantageously used. Where any of these points are questionable, the value of such machinery must not be implicitly assumed.—Lond. *Elec. Rev.*, October 28.

ELECTRO-PHYSICS AND MAGNETISM.

Perforation Distance of Air.—GROB.—An account of experiments in which he studied the law of the change of the perforation distance of air with the impressed voltage. Walter has found that this law is represented by a straight line, the abscissæ of the diagram representing the voltage and the ordinates the perforation distance. The present author's experiments show that this law is correct for high voltages, but that if the curve is determined through the whole range of voltages beginning with very low ones, the curves show a distinct bent on a certain point after which they become a straight line. This bent depends on the capacity of the electrodes and the wires leading to them. The form of the electrodes is of influence since it changes the capacity. He concludes that any rule on the absolute value of the perforation distance is very uncertain and that the designer of high-tension apparatus should take great care not to make the air-gaps too small. He remarks that when building high-tension transformers and testing them with high voltages he sometimes observed sparks of much greater length than would correspond to accepted rules. The designer should try to avoid increased voltages due to resonance altogether.—*Elek. Zeit.*, November 10.

Electrolytic Wave Detector.—ROTHMUND AND LESSING.—An account of an investigation of Schlömilch's electrolytic detector, which goes to show that the effect of the detector is not due, as Fessenden thought, to the evolution of heat, but to a process of depolarization. They used a point made of platinum wire, 0.01 mm. thick, in dilute sulphuric acid. The receiver is shown in Fig. 3, which also shows

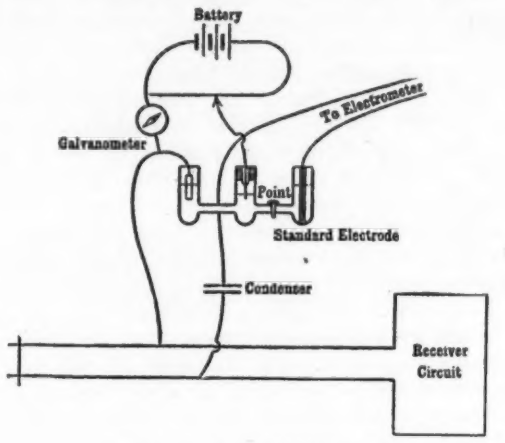


FIG. 3.—WAVE DETECTOR.

the standard cell used for determining the polarization of the detector cell. The reaction of the detector sets in at very low differences of potential, the impact of electric waves producing an increase in the current strength and a lowering of the e.m.f. The point may be either an anode or a cathode, and the chemical process is without any influence. With the same electrolyte the sensitiveness varies as the conductivity. Ordinary voltaic cells show an increase of both e.m.f. and current under the influence of electric waves when one electrode consists of a fine point.—*Annalen der Physik*, No. 11; abstracted in Lond. *Elec.*, November 4.

The Passive State.—BERNOUILLI.—A contribution to the optical investigation of the passive state of metals. Micheli found that when iron becomes passive its principal angle of incidence diminishes from 74° to 69°, and its princnpal azimuth increases from 28° to 29°. From this he concluded that the modified layer is solid and has a considerable thickness. In chromium Micheli failed to obtain any visible modification of the optical constants on acquiring the passive state, but the present author now shows that such a modification may be obtained on producing the passive state, not with nitric acid, but by a boiling solution of quinone in benzol. The active and passive states had to be produced alternately several times before a measurable effect was produced. The e.m.f. varied by about one-fifth volt, and the principal angle of incidence by about 5°, as in iron. The author found an explanation for the constancy of the optical constants when the passive state is produced by nitric acid by showing that the chromium so treated absorbs oxides of nitrogen, which neutralize the passive effect. The author believes that the passivity is due to a surface layer of some compound of chromium, as was originally supposed by Faraday.—*Phys. Zeit.*, October 15; abstracted in Lond. *Elec.*, October 28.

REFERENCE.

Radioactivity.—DIMMER.—An illustrated summary of the main results of recent researches on radioactivity.—*Zeit. f. Elek.* (Vienna), September 25, October 2.

ELECTRO-CHEMISTRY AND BATTERIES.

REFERENCES.

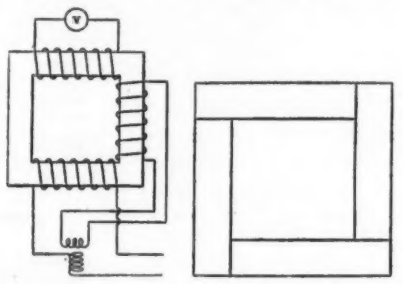
Electrode Potential.—SANDS.—The first two parts of a Faraday Society paper in which he describes a method for measuring the potential of electrodes in stationary liquids and of determining the changes of concentration at the cathode during electrolysis. The main object of the method is to determine electrode potentials in solutions, the concentration of which in contact with the electrode should be known as accurately as possible, while convection currents are carefully avoided.—Lond. *Elec.*, October 28, November 4.

Aluminum.—POOL.—A Faraday Society paper suggesting as a new source of aluminum the laterite deposits of Central India, which are generally classified as clay, but are really much more similar to bauxite.—Lond. *Elec. Eng.*, October 28.

Sewerage Sterilization.—An article on an attempt of an English company on the production of sodium hypochlorite by electrolyzing sodium chloride, for sewerage purification.—Lond. *Elec. Rev.*, November 4.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Testing of Transformer Iron.—WILD.—Since it is apparently impossible to reduce the laws governing the total loss in transformer iron to a simple formula, tests should be carried out under the actual conditions as to induction and frequency with which the iron will be used in practice. The wattmeter is the best instrument for this purpose, although it gives only the total losses in the iron. The arrangement of the tests recommended by the author is shown in Fig. 4. The iron under test is wound with three circuits, namely, one



FIGS. 4 AND 5.—TESTING TRANSFORMER IRON.

primary and two secondary circuits. An electrostatic voltmeter, *V*, is connected across one secondary. This measures the induction. The shunt coil of the wattmeter is connected across another secondary winding. The series coil of the wattmeter is connected in series with the primary winding. By this arrangement the C^2R loss in the primary winding is eliminated from the wattmeter reading. The shunt loss can be made small and is easily calculated from the ratio of the windings, the reading on the voltmeter and the known resistance of the shunt circuit. Another great advantage is that by varying the windings the wattmeter constant can be varied to obtain good readings on the wattmeter under all conditions. This is the method employed at the Westminster Electrical Testing Laboratory. The apparatus used is as follows: A set of standard coils wound on square bobbins are permanently fixed on to a wooden base. There are six voltmeter coils, three wound with 2,000 turns each and three with 500 each. The coil for the shunt of the wattmeter consists as a rule of 20 turns. The primary coil consists of two turns only and carries up to 50 amp. The wattmeter is of the reflecting pattern, and with 160 ohms in series with its shunt coil and the above winding on the iron to be tested reads up to 11 watts. By varying the windings good readings can always be obtained on both the wattmeter and the voltmeter. The iron is obtained in the form of strips 7 in. long and 1 in. wide. They are arranged in the standard coils, as shown in Fig. 5, with butt joints and breaking joint in alternate layers. Guides are provided to keep the stampings in position. The apparatus takes about 5 pounds of iron. Before commencing a series of tests it is necessary to determine the weight and mean cross-section of the iron. The latter is best determined from particulars of the weight, specific gravity and length of each piece. For the sake of uniformity transformer iron tests should always be carried out with current from a sine wave alternator. If this is not practicable the form factor of the alternator should always be stated. —Lond. *Elec.*, November 11.

High Temperature Measurements and Heat Losses from Glowing Filaments.—HARTMANN.—An account of experiments, made at the suggestion of Nernst, on the radiation from absolutely black pencils less than a millimeter in diameter. The pencils were prepared from a paste of spongy platinum, which was compressed to rods; the rods were dried and then kept for some time at a white heat in an oxy-hydrogen flame. Electrode hooks of silver having been welded to the ends of the pencils, the heating during the radiation experiments was effected with the aid of an accumulator battery of 70 volts. The temperatures were determined by means of the Wanner optical pyrometer. In control tests the Holborn-Kurlbaum principle was applied. To this end a fragment of magnesia was heated in a small tubular electric furnace, and the temperature of the magnesia measured with the help of a thermo-junction dipped into it. The glowing pencils were then brought in front of the bright hollow of the platinum furnace and the current through the pencil was raised until the pencil could no longer be distinguished against the glowing background. It was thus found that the Wanner pyrometer registered too low temperatures for the thin rods, owing to a diffraction effect, the existence of which had been suspected by the experimenter. The diameters of the four pencils of platinum black were 0.069, 0.042, 0.0275 and 0.014 centimeter. The temperatures to which measured currents should raise these pencils were calculated according to the Stefan-Boltzmann law, and the difference between the calculated and the observed temperatures gave the loss of heat by convection and combustion. The experiments were made at temperatures ranging from 1,000 to 1,900° C., absolute. Taking only temperatures up to 1,600° C. the loss by conduction and radiation in air was found to be proportional to the absolute temperature, and is approximately expressed by the formula: Loss in watts $= 0.001\ 1\ T$, where 1 is the length of the wire in centimeters and T the temperature on the absolute scale. The coefficient, 0.001, varied with the temperature, but not much; it was 0.00115 for the thickest pencil and 0.00106, 0.00097, 0.000915 for the others in succession, so that 0.001 may be accepted as average value for pencils or wires a few tenths of a millimeter in thickness. Experiments were also conducted in vacuo and again after admitting air into the exhausted vessels, the respective figures being loss in vacuo, 1.05 watt per centimeter length of wire; in air, 1.55; difference, 0.5 watt at 1,000° C.; the difference became greater at the higher temperatures, and rose to 1.4 watt at 1,900° C. Hartmann also refers in his paper in the *Physikalische Zeitschrift* of September 15 to experiments, not yet published, made by Wassiljewa on heat conduction in the air. She determined the conductivity with wires of various diameters at low temperatures, the difference of temperature between the wire and the air about it being small—only 1° C. Extrapolation of Wassiljewa's figures to the high temperatures employed by Hartmann did not allow of a satisfactory separation of the conduction from the convection losses, however.—Lond. *Engineering*, November 11.

REFERENCES.

Factory Testing.—WORKMAN.—A continuation of his serial dealing with tests of alternating-current, synchronous generators. He first deals with loss tests and describes how to determine the copper losses, the iron losses and the friction losses. He then describes the generator short-circuit test made to obtain an estimate of the effect of armature impedance in reducing the voltage of the machine for constant speed and field current. He finally deals with the compensated field circuit of an alternator and passes over to tests of regulation and efficiency which are briefly discussed.—*Elec. Club Jour.*, November.

Water Collector.—SMIRNOW.—An illustrated description of a water collector which is rapid in its action and quite satisfactory for measuring the electric field in balloon voyages.—*Phys. Zeit.*, October 1; abstracted in Lond. *Elec.*, October 28.

Slip Indicator.—DOOLEY.—An illustrated description of a slip indicator designed by Tingley. In its electrical action it is similar to that of a direct-current dynamo commutator. It is adapted to motors of but one given number of poles, necessitating a separate and complete device for each style of motor according to its number of poles. It is, however, of simple and inexpensive construction.—*Elec. Club Jour.*, November.

MISCELLANEOUS.

English Manufacturing Plants.—An illustrated description of the Lancashire Dynamo & Motor Companies' Works at Trafford Park is found in Lond. *Elec. Rev.*, October 28; an illustrated description of the Hadfield's East Hecla Works, Sheffield (special tramway track work, manganese steel for points and crossings, etc.) is given in Lond. *Elec. Eng.*, November 4.

Electric Smelter in Canada.

It is probable that an electric smelter will soon be established at the city of Peterboro, Ont., near the Trent Canal. The present plan is to use the ore from the Belmont Iron Mines, located about 30 miles from Peterboro, close to the Trent River. The ore was for a number of years worked successfully and shipped to the United States, but the mode of shipment then being costly made the venture non-productive. With the completion of the Trent Canal, and the cheap and easily developed power at Peterboro, the mines can, it is stated, be operated at a profit.

The Electrolytic Meter.

By R. S. White.

The mention of the electrolytic meter is likely to bring up the obsolete types of the early days of electric lighting in the minds of those who have not followed the remarkable development that has been made in this branch in recent years. This development has led to types of electrolytic meters which have little in common with the crude early types, from which they differ in the method of application of the electrolytic principle and most radically in form. In Europe, where most of the work on the modern electrolytic meter has been done, this type during recent years has succeeded in replacing the motor meter on many central station circuits.

Perhaps the most simple type of the modern electrolytic meter is the Bastian meter, which is particularly well known in England, where it has been in commercial use for some years. In this meter the electric current decomposes the water of an electrolytic solution, the level of which is gradually lowered in strict proportion to the amount of current which passes. In the old style of instrument, the electrolytic consisted of a very dilute solution of sulphuric acid and water to which was added a non-freezing mixture. Platinum electrodes were used with this solution, requiring vulcanite tubes for support and protection.

In the further development of the meter, it was found that with pure nickel electrodes immersed in an alkaline solution, the vulcanite box and tubes were no longer necessary, and a simpler and stronger construction was permitted. Besides this, the new alkaline solution was found to be practically non-freezing, and the nickel electrodes being much larger, reduced the resistance of the cell, the "drop" becoming about that necessary for the decomposition of water, or a little less than two volts. The electrolyte changes in resistance somewhat according to its density, but as no shunt is required in the meter, and as all the current passes through the solution, there is no resulting error.

This electrolytic meter is quite accurate at all points of the curve, and no current, however small, can hope to escape registration, a point of considerable importance where a large number of small consumers is concerned.

Vibration does not effect the electrolytic meter, but it is a cause of disturbance and error in the commutator motor meter. For it soon results in more or less injury to the jewel and pivot bearing, with a consequent loss of accuracy on light loads. If not discovered and a new jewel or pivot supplied, an increasing loss on all loads is sure to follow. Vibration may also increase the sparking effect on the commutator and brushes, roughening the contact surfaces appreciably and tending to slow the meter.

Heavy overloads are well borne by both meters, if we except short-circuits, the magnetic shock of which is usually detrimental to the magnets of the motor meter. Motor meters, too, should be installed in a level position, as any deviation causes a loss of sensitiveness to small currents. Dust and dirt where abundant sometimes gather on the commutator and brushes, increasing the friction and introducing small losses until remedied by the inspector.

Then again, the use of the starting coil in the commutator type of motor meter sometimes introduces troublesome errors, especially if the potential of the circuit varies to any extent. However carefully adjusted this coil may be for the standard potential, any considerable increase will cause the meter to "creep," i. e., to register when no current is being used. Or, if the coil is not well adjusted, the meter will be "sluggish" on small loads, when the potential is low.

The Bastian electrolytic meter requires to be periodically filled with water, but as one filling usually lasts from four to six months, this simple operation can hardly be compared to the careful testing and readjusting necessary to keep the commutator meter in efficient condition.

With a meter plainly indicating its record on a straight line scale, disputes will not so easily arise between consumer and producer. For it is well known that few persons can read the ordinary motor meter dial correctly, even with considerable explanation.

In three-wire service, two recording elements enclosed in a single case are employed, one being connected to each of the outer mains. This arrangement shows the consumption on each side of the circuit, and in case of trouble is also quite advantageous, as the registration of this meter is not disturbed by the reversal of the current. With the three-wire motor meter, however, when the supply is locally changed over from a three-wire to a two-wire connection, the value of the record is destroyed, and troubles with the customer are more likely to follow.

The use of glass outside of the window for the reading of the instrument, common to all registering meters, is confined in the Bastian meter to a simple tubular form of receptacle for the electrolyte, firmly supported, and well protected by a metal case. The meters withstand shipment to distant parts of the world, with no loss from breakage.

In the consumption of electrical energy we find the electrolytic meter the more economical, for while the "drop" or loss of potential across its terminals is somewhat greater than the "drop" in the field coils of the motor meter, yet this greater "drop" occurs only when current is being used, while in the commutator motor meter the little current in the armature coils is silently running to waste all the time. This loss of energy in the armature circuit amounts to two lamp hours per day, and though not of any great importance in the larger installations, becomes of more serious consideration in the case of the small customer.

Coming to the question of error in registration due to the inherent difference in the types of the instruments, let us examine the matter more carefully. The electrolytic meter is essentially a current meter, i. e., it records the amount of current that is passed through it. If the electrical potential or "pressure" of the circuit is raised, the current increases, too, and the current meter will register this increased amount. When the potential is lowered the smaller current resulting will be likewise recorded.

ELECTROLYTIC METER.

On the other hand, in the watt-hour meter, the speed of rotation depends not only on the amount of current being used, but is also influenced by the potential of the circuit which governs the small current always flowing in the armature coils of the instrument; so that in this type of meter the changes of speed due only to the fluctuations of potential are slightly more marked than in the current meter, i. e., it runs a little faster than the current meter when the potential is raised, and runs a little slower than the current meter when the potential is lowered.

If, however, the potential variations are not excessive, or if considerable fluctuations occur and the resulting average potential is approximately normal, then the difference in the readings of the two instruments becomes a negligible or a vanishing quantity.

Suppose, for example, the potential of a normal circuit of 115 volts is raised two volts, and kept at 117 volts for one month, then the current meter record will be somewhat less than two per cent. lower than it ought to be. If the potential be maintained at 113 volts then the record of the current meter will be somewhat less than two per cent. more than it should be.

Thus we see that this error in the calibration of the current meter slightly favors the consumer when the potential is high, and slightly favors the producer when the potential is low.

If we compare this error in the current meter record with the losses of registration due to the use of a jewel and other delicate mechanism of the watt-hour commutator motor meter, it will even at the end of one month's use in the majority of cases be found to be the smaller of the two, and by the end of six months' service it will have sunk into comparative insignificance.

That in practice no appreciable effect is introduced by the ordinary changes in the potential is shown by the fact that in England and on the Continent, where more attention is paid to detail and economy than in this country, the current meter reading in watt-hour units is extensively employed and its use moreover is rapidly increasing.

It is then more especially in meeting the requirements of the small consumer. where a reliable meter is needed at once cheap to install

and inexpensive to operate, that the chemical meter is so well adapted. For with a comparatively high first cost, a necessity for skilled inspection and a constant waste of energy in the watt-hour instrument, the expenses of efficient meter maintenance may easily be out of proportion to the income derived.

Electricity is being supplied and used under such a variety of conditions that in order to obtain the best results a little latitude would seem necessary in the use of instruments. While it would be very nice for the central station manager to use only one kind of meter for all kinds of service, experience hardly supports such judgment, and it is no longer considered the best practice to use the commutator type of motor meter on alternating circuits.

It will be admitted that the electrolytic type of meter, as represented in its latest construction, is remarkably simple and free from sources of error, and that however perfect the commutator type of motor meter may seem, the actual results of service necessitate its skilled attention.

We may fairly conclude, then, that both types of meters, differing radically in construction and operation as they do, have their own proper field of usefulness and service. And that under such conditions both may be depended upon to give good commercial results.

More New Types of Prime-Movers at World's Fair.

An uncertain but hopeful situation confronts those who are interested in the generation of electric power, for in place of the reciprocating steam engine which was alone in the field in years past, the choice now lies between a number of types of prime-movers. It has taken several generations to develop the reciprocating steam engine to the point where it proved reliable, economical and could be built in large units suitable for connection to electric generators. This development has reached a climax where it seems that little more can be expected from it, but now other types such as water wheels, turbines and internal combustion engines are being adapted to the use in electric power stations on a large scale. These different forms of prime-movers all connected to electric generators are exhibited at the Louisiana Purchase Exposition. While these are not the largest units, yet they are representative and each is shown in full operation. Perhaps the turbo-generator is of more importance to the electrical industry than any new development of recent years. The General Electric Company, the Westinghouse Company, the De Laval Steam Turbine Company and the Hooven, Owens, Rentschler Company all have steam turbines, each of a different type. Some of these have already been illustrated and described.

The largest turbo-generator at the fair is one of 3,000 hp installed by the General Electric Company in the Machinery Building. The turbine, as previously noted, is of the vertical type, direct-connected to an alternating-current generator producing 6,600 volts at 25 cycles with a speed of 750 r.p.m. This is the first Curtis turbine to be built with the condenser in the base, and with this arrangement this unit occupies a floor space of 10 ft. 7 in. by 11 ft. 1 in. and 22 ft. 4 in. above the foundation.

The turbo-generator exhibited by the Westinghouse Companies, also previously described and shown in these columns, is of the horizontal type. The three essential parts thereto are the rotor, stator and the balancing pistons. The rotor consists of a cylinder of three

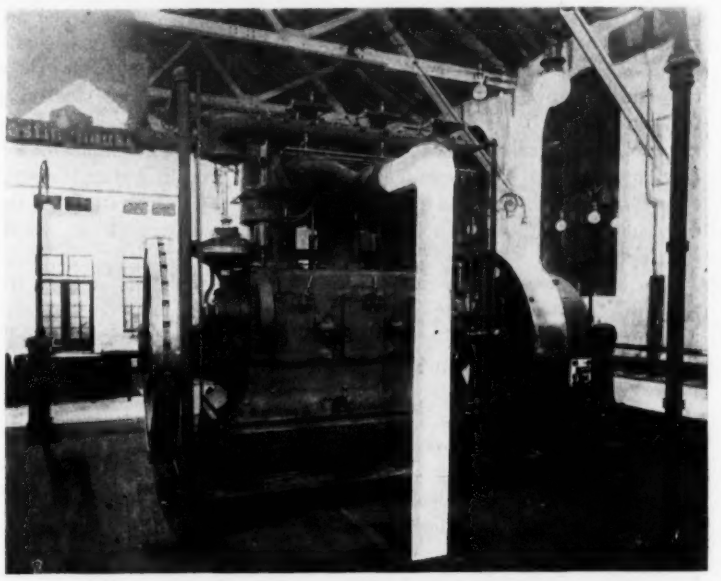


FIG. 2.—125-HP WESTINGHOUSE GAS ENGINE.

or more drums of increasing diameter, upon the periphery of each of which are mounted numerous rings of radial vanes. Direct-connected to the rotor shaft is the rotating field of the generator. The special construction of the rotating field of the Westinghouse turbo-generator can be seen in the Westinghouse exhibit in the Palace of Electricity, where a 400-kw generator of the same size and type as that in operation in Machinery Hall is set up for inspection.

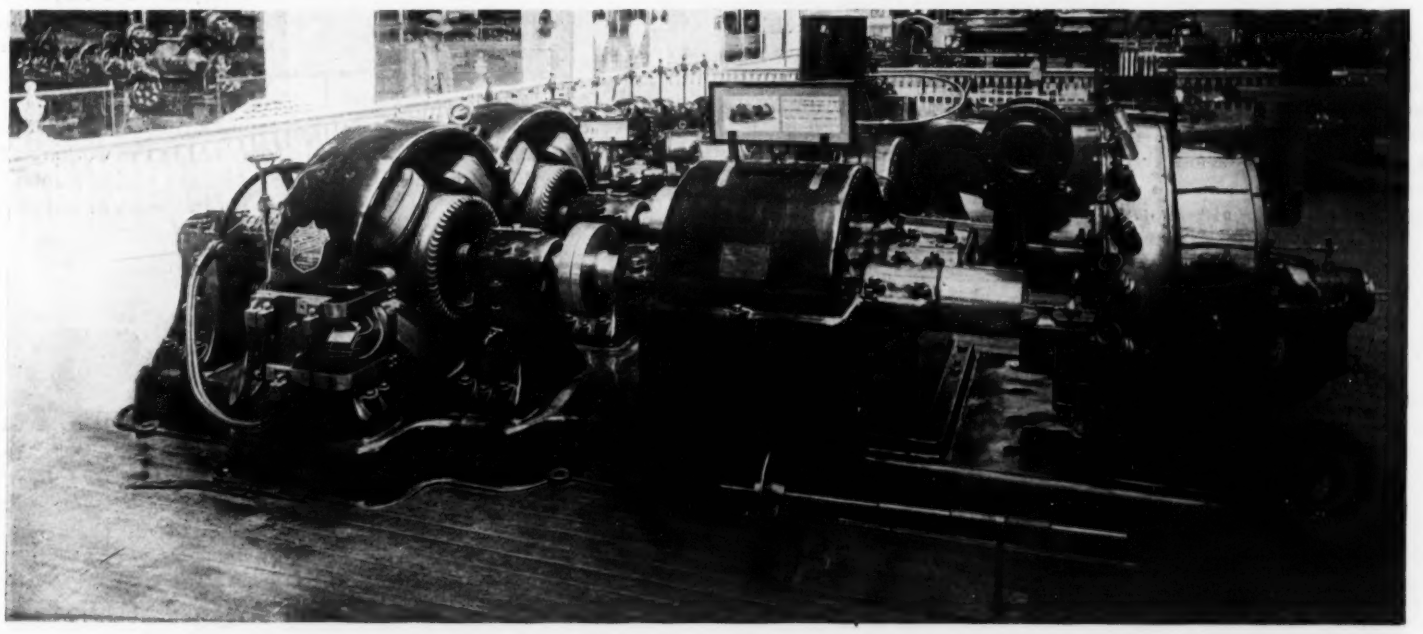


FIG. 1.—DE LAVAL TURBINE EXHIBIT AT ST. LOUIS.

One of the latest designs of steam turbines, beyond the De Laval, which is here shown in Fig. 1, is the Hamilton-Holzwarth horizontal type, which is exhibited in a 1,500-hp size. It is directly connected to a 1,000-kw Bullock alternator and runs at 1,500 r.p.m. The set occupies a floor space of 9 ft. 8 in. in width by 40 ft. 2½ in. and weighs about 162,000 pounds (Fig. 3). In the turbine proper there is a plurality of stationary discs and running wheels, both of which have vanes around their circumference. The characteristic of the turbine is that steam is expanded only in the stationary blades. The radial height of the vanes of the stationary blades is increased

to correspond to the volume to which the steam is expanded. Balance pistons are left out, because the axial thrust of the running wheel shaft is easily taken up by the thrust ball bearing, the steam pressure being the same on both sides of the running wheel. The purpose of the stationary disc is to prepare the steam for its action on the wheels. Within the vanes of the stationary discs the steam has to expand to accelerate and to change its direction with the best possible efficiency. The stationary discs are located in grooves in the turbine casings. The vanes are drop-forged steel, milled and located in a groove on the outside periphery of the discs. The vanes are fastened to the discs by rivets. After being fastened, the disc and vanes are ground on their outside edges, giving the vanes the profile they should have for efficient steam expansion. A tough steel ring is then shrunk on the outside periphery of the vanes and steam channels. The running wheels are built with cast steel hubs. Steel discs are riveted to both sides of this hub, forming circumferential ring space into which the vanes are held by means of rivets. On the outer edge of the vanes a thin steel band is tied around the wheel, in order to give an outside wall to the steam channels.

The live steam first passes through a steam separator and to the main inlet valves which have an extended stem that is connected with a floorstand and handwheel located on the floor close to the high-pressure end of the turbine. Steam then passes through the regulating valve, and from there through a curved pipe to the head of the high-pressure turbine. From the ring channel of this head the steam flows through the first set of stationary vanes, which changes its direction and imparts the necessary velocity. These vanes are rigidly connected to the head. From here the steam flows in a full cylindrical belt, interrupted only by the vanes of the first running wheel, and from the first running wheel to the following stationary discs, and so on. From the last running wheel the steam passes through pipes to the front head of the low-pressure casing and thence to the condenser. All steam, oil and water piping and exterior connections are within and below the bedplate. All bearings of the turbo-generator are fed with a sufficient quantity of oil to insure cool running. The oil flows from an oil tank of large capacity in the bedplate, to the oil pump, which is driven by means of worm gearing, by the turbine itself. From this pump the oil is forced through the bearings and back to the oil tank. In the oil tank it is cleared by flowing through a strainer, and at this point it has sufficient time to radiate part of the heat to the walls of the bedplate.

The exhibits of oil and gas engines cannot be compared with that of the steam turbine for central station service. The largest unit in operation is a 280-hp, three-cylinder vertical Westinghouse engine in the United States Geological Survey Coal Testing Plant in the Mining Gulch. A 225-hp horizontal gas engine direct-connected to a generator, as shown in the illustration, Fig. 2, is in constant operation in the Westinghouse exhibit, as previously noted in these pages. The internal combustion gas engine for isolated plants and

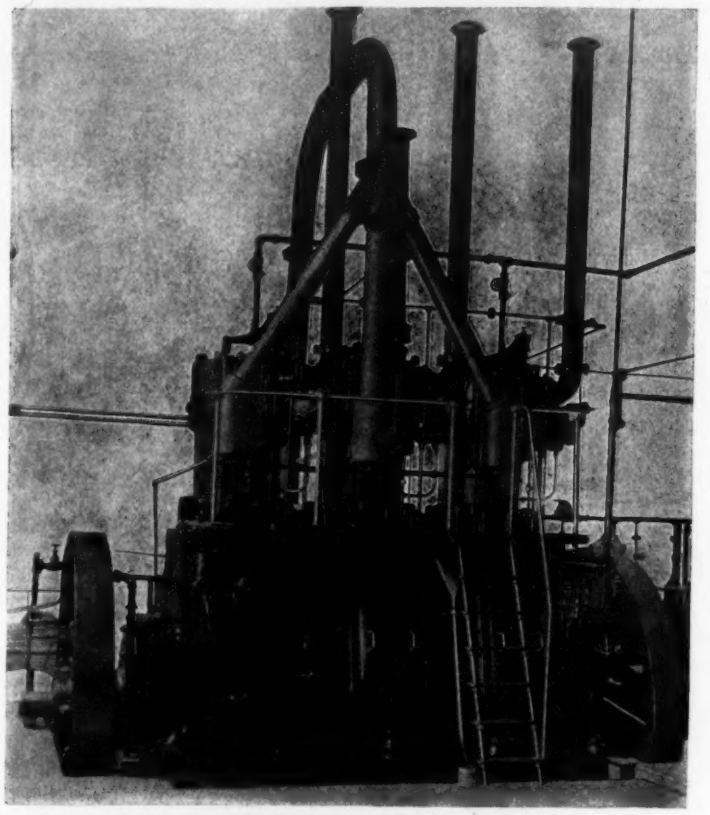


FIG. 4.—DIESEL MOTOR.

equipment of central electric lighting plants operated in connection with large gas works; and in general power application wherever natural gas is abundant. The record of one 65-hp Westinghouse two-cylinder vertical gas engine, which ran 1,157 hours without stopping, and then was shut down for the repair of a broken belt, shows a total of 8,230 hours run out of 8,472 hours elapsed time, only about 16 per cent. of the 242 hours shutdown being attributable to engine repairs. In the contemporaneous operation of a 1,250 indicated hp steam station employing compound condensing engines and water tube boilers, and a 685 brake hp Westinghouse gas engine station, with coal at $4 a ton, it was shown that there was a saving in the cost of fuel of 45½ per cent. in favor of the gas station.

A gas engine differs from a steam engine primarily in that the functions of both boiler and engine are combined in the working cylinder, the only high-pressure point in an entire gas engine plant. In the case of gas engines in which gas from natural wells or from city

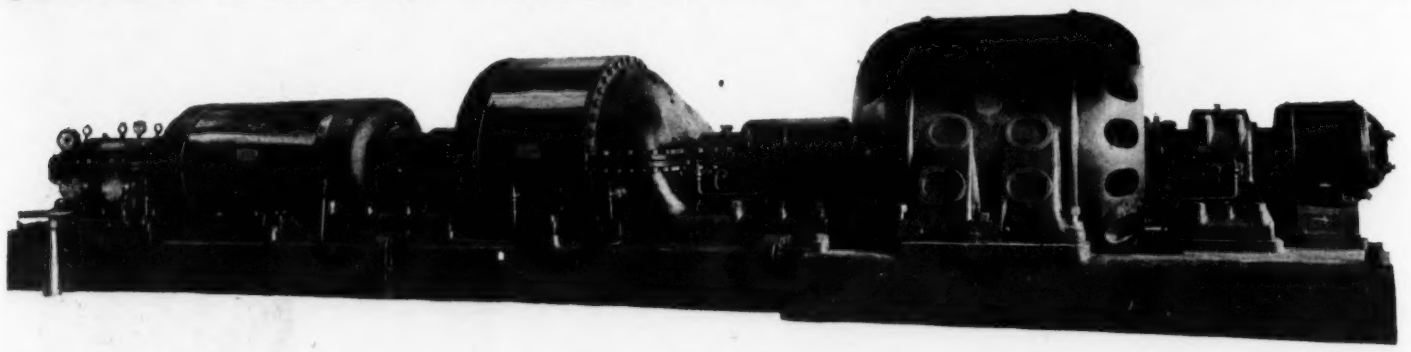


FIG. 3.—HAMILTON-HOLZWARTH TURBINE.

eventually central stations is worthy of note because of its economy and simplicity, and because its commercial usefulness is materially enhanced as each stage of progress is recorded in the improvement of gas producer methods. The 225-hp engine on exhibit is the smallest size of the horizontal type at present constructed at the East Pittsburg works. The gas engine's special advantages are not alone a minimum fuel and heat consumption and the elimination of boilers, steam pumps, condensers, return traps and other steam plant auxiliaries, and of the heat losses and leakage from such auxiliaries, both when the steam engine is in operation and when it is shut down—it has special fields of service in the effective utilization for power of blast furnace gas daily going to waste in the mills of the world in the mains is utilized, as in those in the Westinghouse exhibits at the fair, the simplicity of the installation is ideal. When gas producers are used in connection with an internal combustion engine, power can be stored during light loads in the form of gas in the holder, and there is little loss of heat in radiation from the brick holder during long shutdown intervals. Westinghouse gas engines all operate on the four-stroke cycle, the piston drawing in a mixture of gas and air on the forward stroke, and compressing it to a high degree within the clearance space on the return stroke, whereupon it is ignited by an electric spark, the pressure resulting from the expansive force of the rapidly burning gas mixture driving the piston forward and the exhaust valves opening at the end of the stroke

for the escape of the burned gas, while the piston upon the fourth or exhaust stroke completely cleans, or scavenges, the cylinder, thus preparing for a new charge of gas and air properly proportioned. This cycle of operation is repeated in each cylinder. In single-acting engines pressure is exerted upon one side of the piston only; in double-acting engines it is exerted upon both sides. The double-acting arrangement is peculiarly adapted to the driving of large electric generators, especially alternating-current generators working in synchronism upon the same supply circuit.

One of the recent and original developments in prime-movers is the Diesel engine, which derives its power from the burning of fuel oil injected into cylinders filled with compressed air at a very high temperature. Three of these engines furnished by the American Diesel Engine Company with Bullock generators comprise the power plant of the Tyrolean Alps (Fig. 4). Each engine has three cylinders of 16 x 24 in. and develops 225 hp at 160 r.p.m. and occupies a space 9 x 17 ft. and 12 ft. in height. These were of the largest capacity when erected, although the American company is now constructing some of 500 hp and the German company up to 1,600 hp, consisting of four engines with four cylinders coupled together for railway work. The initial cost of such a plant is between 60 and 70 dollars per horse-power. The engine together with an underground oil storage tank comprises the entire power equipment. In this plant the engines furnish 100 hp-hours on the switchboard, while running at loads varying during the day from one-quarter to full load, with a consumption of only 7½ gallons of common fuel oil from Whiting, Ind. At 3 cents per gallon this means 100 hp per hour at 2¼ cents, or 100 kw at 3.15 cents. The cycle is the same as that of the gas engine, but in other respects the operation is analogous to that of the steam engine. Its first stroke draws the cylinder full of pure air, the second compresses the air to about 500 pounds per sq. in., with a consequent temperature sufficient to ignite any fuel which may be injected into it, and at the beginning of the third stroke a small quantity of fuel oil is sprayed into the cylinder under a pressure of 900 pounds per sq. in. The oil ignites instantly and burns during admission, which is about one-tenth the stroke, but this period of admission can be regulated by the governing mechanism of the engine. The stroke is furnished by the expansion of the burned products. The fourth stroke discharges these products of combustion and leaves the cylinder empty and ready for another suction stroke. It is evident that the work expended in compressing the cylinder volume of pure air is given off again to the shaft of the engine during the combustion of motor stroke, so that the loss is simply the frictional loss during the compression stroke. There is one disadvantage to this engine common to all four-cycle engines, that there is but one motor stroke for every two revolutions. For electric light work triple-cylinder engines with heavy fly-wheels successfully overcome this, while for electric railway work resort is had to still larger fly-wheels and six cylinders by coupling two triple-cylinder engines at the two ends of the same dynamo shaft.

Harrisburg Works to Build Turbines.

Another engine building concern is entering the turbine field—the Harrisburg (Pa.) Foundry & Machine Works, for which Mackenzie, Quarrier & Ferguson, of 114 Liberty Street, New York City, are the local representatives. The Works are engaged in the construction of a horizontal turbine of 300 hp capacity.

It is not proposed, however, to put the Fleming turbine, as it will be called, on the market until success is assured by actual test in operation at the Harrisburg factory. As soon as the present machine is built it will be used in connection with a generator to carry the factory load.

This turbine, which has been designed principally by Mr. Benjamin T. Allen, chief engineer, and Mr. Thomas Hall, chief designer at the Harrisburg shops, will be of condensing and non-condensing type. Its features will comprise condensing economies in the stages down to atmosphere and the small space occupied.

Fatal Ray Treatment.

A dispatch from Toledo, Ohio, says that a man in that city has died as the result of treatment by the X-ray. He had a growth upon his lip which was treated by the X-ray. The treatment was so painful that he lost his reason and was taken to the Toledo State Hospital.

Motor Equipped Pump Building Shops.

The recently completed plant of the Jeanesville Iron Works Company at Hazleton, Pa., affords one of the best examples in this country of a thoroughly modern manufacturing plant, carefully engineered and arranged with a view to obtaining by the aid of electricity low shop cost and, at the same time, the greatest perfection in the product. In 1852 James C. Haydon began the manufacture of mine pumps at Jeanesville, Pa. From an humble beginning the business expanded year by year, as the merit of the pumps became more widely known, and, as is usual in such cases, the plant was enlarged at intervals to accommodate the growing business. The

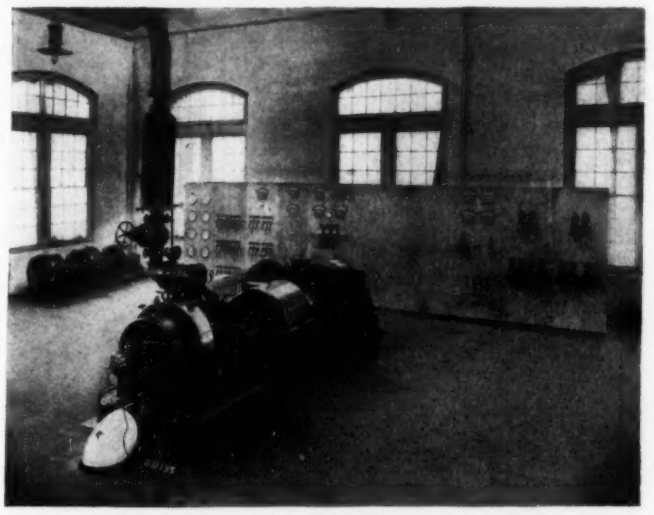


FIG. 1.—DE LAVAL TURBINE.

result was a series of structures of dissimilar architecture with numerous dark nooks and corners—in short, a combination of buildings such as many old-established manufacturing industries are conducted in. The management of the plant had long felt the need of newer and larger quarters, but engrossed as they were in developing their pumps and in establishing a market for them in all the mining districts of the world, rebuilding had been long deferred. Some two years ago they determined to erect their new plant at Hazleton, Pa., a site which offered particular advantages. Dodge

FIG. 2.—GENERAL VIEW OF FOUNDRY WITH ELECTRIC CRANE.

& Day, the modernizing engineers, of Philadelphia, were commissioned to engineer the equipment. Ballinger & Perrot, architects, co-operated with them in the construction of the buildings. Within a year from the signing of contracts the new plant was in full operation. Reinforced concrete was the principal material of construction. The new buildings present a most pleasing appearance. The raw material is received at the plant on a railroad siding. It is dumped from the cars into receiving bins and is carried to the foundry over a C. W. Hunt & Co. industrial railway. It is then raised to the cupola platform by an electric elevator. The sequence of operations from that point to the loading of the finished product on cars—which run directly into the machine shop—is never inter-

rupted. The entire new plant consists of six buildings. The main building comprises the foundry, 107 ft. x 192 ft., the casting and cleaning department 41 ft. x 160 ft., and the machine and erecting shop 304 ft. x 107 ft. In the latter are located a room for small stores and a blacksmith shop. The other five buildings are the pattern shop, the pattern storage house, the offices, the power house and a stable.

The casting cleaning department which bisects the main building is separated from the foundry and machine shop by two fire walls extending above the roof. The eastern end of the main building is of temporary construction to permit of longitudinal extension. As the flask storage is at the western end of the plant, directly beyond the foundry, this end of the latter building is also not of permanent construction, thus not only permitting of future extension, but also allowing the 20-ton electric crane to pass in and out with its load (Fig. 3). This end of the foundry building is provided with large rolling steel shutters.

Due consideration was given by the architects to the location of the various buildings from the standpoint of the fire risk, and also that one building might not interfere with the natural lighting of another. The entire side of the pattern storage building facing the foundry is a solid wall without windows. All of the electric lights, both the arc and the incandescent, are on the 110-volt circuit. There are installed eighty Jandus 5-amp. interchangeable arc lamps.

The operation of the entire plant is primarily dependent upon the power equipment. The engineers chose as the motive power direct-current electricity. With the exception of some pneumatic, ground-

FIG. 3.—FLASK STORAGE YARD WITH RUN FOR FOUNDRY ELECTRIC CRANE.

operated traveling cranes in the casting cleaning department, all of the machinery in the shops is driven electrically.

A 300-hp De Laval turbine connected to two 100-kw Crocker-Wheeler generators furnishes power for the entire plant at the present time. In the near future another unit of the same size is to be installed. Multiple voltage for obtaining the desired speed regulation throughout the shops is obtained by the introduction of a type D Crocker-Wheeler balancer set, consisting of three units—40, 80 and 120 volts—each of these voltages being controlled by three field regulators. The compactness of the outfit and the small floor space required for the electrical power machinery is apparent from the illustration of the power house, Fig. 1. The adoption of a turbine without a condenser was governed by several important factors, not the least of which is the low cost of the steam generated, due to the fact that coal in this locality is obtained at about 90 cents per ton.

In the engineering room there is also a 12 x 18 x 12 x 12 Ingersoll-Sargeant air compressor supplying air to the traveling cranes in the casting cleaning department, jib cranes in the foundry and the various pneumatic tools. Between the engine and the boiler rooms are located the artesian well pump, the boiler feed pump, the vacuum pump, the feed water heater and a 1,000-gallon underwriters' fire pump, which receives its supply from a 200,000-gallon reservoir. The means of fighting fire consist of fire plugs and hose lines located about the premises.

The clinkers from the boilers are thrown on a grating over an elevator boot located in the boiler house and are broken to the proper size, dropped through the openings and into buckets of a steel-encased elevator, made by the Link Belt Engineering Company, whence they are carried to a cylindrical receiving bin of 5 tons capacity. They are dumped into trucks through a gate in the bottom of the bin and carted away.

Fig. 2 is a general view of the interior of the foundry. On the left, immediately in the foreground, is a cylinder pit, 12 ft. in diameter and 9 ft. deep. The plunger pit, which forms a third of a circle 28 ft. outside diameter and 20 ft. inside, 4 ft. wide by 6 ft.

FIG. 4.—GENERAL VIEW OF MOTOR-DRIVEN MACHINE SHOP.

deep, adjoins the cylinder pit. The weight pit is 13 ft. 4 in. wide and 5 ft. deep. These pits are served by individual jig cranes operated pneumatically. In the right-hand bay are located a cupola, four core ovens, the blower room, moulding department for small castings and sand bins and sifters.

The cupola is of 12-14 tons melting capacity per hour. Another similar unit is now being installed. The charging platform is served by a two-ton electrically-driven elevator provided with automatic stops at the top and bottom of the lift. There are two worm ladles of 8,000 and 10,000 pounds capacity respectively, with numerous smaller ladles. Every provision has been made for rapid economic handling of the material and ladles throughout the foundry.

Fig. 4 gives an excellent idea of the interior arrangement and layout of the machine shop, the absence of shafting, belts and other overhead obstructions being in marked contrast to the old-time shop. A generous area of glass in the windows and roof affords a uniform distribution of natural light. The floors are entirely unobstructed

FIG. 5.—BORING MILL.

by anything that will interfere with the free use of the valuable floor space. A typical example of the method of driving the larger machine tools by an individual motor is the boring mill shown in Fig. 5.

At the north end of the shop is erecting space where also each pump is tested to far above its rated capacity before being shipped from the plant on the railroad cars which come directly into this part of the shop.

The reconstruction and re-equipment of this plant along electric power lines is interesting in its suggestiveness, as well as because it affords another evidence of the rapid manner in which electricity is being applied to all branches of the manufacturing industries and arts. Not only does such adoption of electric power carry with it higher economies in production, but it makes the working hours of the employes in the shop much more agreeable, that in itself tending to larger output.

Special Applications of Electric Motors at the World's Fair.

BY CLOYD MARSHALL.

THE universal use of electric motors for power purposes has resulted in a wide variety of designs and making the motor a most versatile machine. In many of the later applications the requirement has been for variable speed and several methods have been devised to secure this. The direct-current motor has proven eminently fitted for this kind of work, and the efforts to regulate the speed of the alternating-current motor to its service has met with considerable success. The speed of a motor is determined by the number of conductors on the armature, the strength of the magnetic field in which the armature revolves, and the impressed voltage on the armature. Any one or any combination of these factors may be varied to alter the speed of a direct-current motor. By changing the strength of the magnetic field a speed variation of about 3 to 1 can be reasonably expected. These results are generally brought about by introducing resistance in the shunt field of the motor used. However, a large motor is required since the torque of the motor falls off as the field is weakened. By changing the number of armature conductors receiving current and the field strength a speed variation of about 5 to 1 might be obtained; this, however, requires a large motor with two commutators. The impressed e.m.f. may be altered by putting variable resistance in series with the armature of the motor. This is not wholly satisfactory as the speed of the machine varies with every variation of the load. There is also a large waste of energy in the resistance, but it does not require such a large motor as in the previous case.

Another method consists in putting the armature of the motor across various voltages which are maintained constant. This method as regards size of motor required is on a par with the method of inserting armature resistance. It will be seen that the horse-power of a motor varies directly with the speed, the field strength, current and number of armature conductors. Thus the motor must be of sufficient size to develop required horse-power at the lowest speed required. Suppose a motor is wanted to develop 5 hp at from 600 to 1,200 r.p.m. Considering for a moment the field control system, it will be seen that a machine that will develop 10 hp at 600 turns must be used in order to get 5 hp at 1,200 turns, in the case of the variable applied e.m.f. However, a machine that develops 5 hp at 600 turns may be used as it will develop 10 hp at 1,200 turns, which will be ample. Thus a motor of one-half the size required by field regulation may be used when variable applied e.m.f. to the armature is employed. In the case of field variation control the limit of the size of the motor is at top speed, while in the case of the variable applied e.m.f. the limit is at the slowest speed. It is clear, therefore, that a combination of these systems should give the best results, some of the advantages being as follows: The motor has a practically constant torque regardless of speed; the speed of the motor is but little affected by variations in load. The different speeds are obtained without passing the current through external resistances. There are two systems which are most commonly used—the four-wire and the three-wire. In both these cases a speed variation of about 7 to 1 can be readily obtained, the various voltages being secured by means of a "balancer" running across the line.

For shop practice a voltage of 250 is generally recommended on account of its availability both for power and light. To get the greatest number of variations on the multivoltage system the initial voltage must be divided in unequal potentials. On the four-wire system the best subdivision is as follows: into 60, 80, 110 volts, thus giving six voltages available as follows: 60, 80, 110; 60 + 80 = 140; 110 + 80 = 190; 60 + 80 + 110 = 250.

The Bullock Electric Company has fine exhibits at the World's Fair of direct-current multivoltage systems, using both the three and four wires for distribution. On the four-wire, 250-volt system 26 speeds are obtained, as three steps of field resistance are inserted between each voltage and five steps of field resistance are used after full voltage has been put across the armature. This number of steps is ample for any class of work whatever. The three-wire system, which has the advantage of decreased first cost of installation and the use of standard switches, has a balancer which subdivides the voltage into 90 and 160 volts, and thus three voltages are obtained, viz: 90, 160, 250. Twelve speeds are obtained by this system, by using two field resistance steps for each of the first two voltages and five field resistance steps for the 250 volts. The controllers used may be attached to any part of the machine tool and arranged so as to be operated from the best point for the workman. In the case of a lathe the controller handle is attached to the apron. One of the main points of the system is that any motor may be used on it. Thus in existing installations it is only necessary to add the controllers and balancer. The balancer employed in the three-wire system consists of the direct-coupled dynamos in series with the middle point tapped out, their voltages being respectively 90 and 160. These machines are made in several sizes, but none greater than about 35 kw. This is ample for the largest shops, since only the balance part of the load passes through the balancer. In a large factory the chances are that the machines running will be pretty evenly divided between the various voltages, and thus it seems that the larger the shop the smaller the balancer required, and within certain limits this is proven by experience.

Multivoltage systems of speed control for machine tools are demonstrated by many installations in the Palaces of Electricity and Machinery. Some very large motor-driven machines are exhibited by the Niles-Bement-Pond Company, with Bullock motors attached. The illustration, Fig. 1, shows a horizontal boring, drilling and mill-

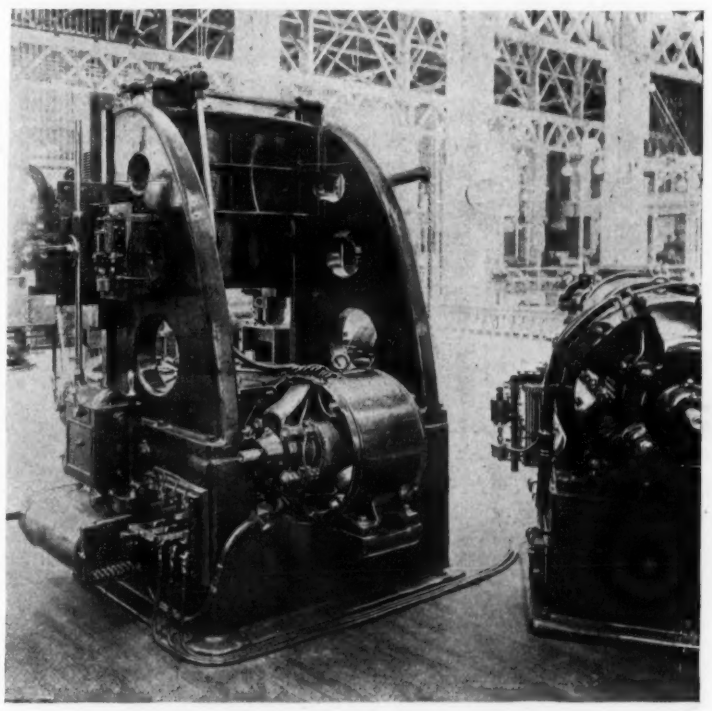


FIG. 1.—BULLOCK MULTIVOLTAGE MOTOR DRIVING BORING MILL.

ing machine which is designed for the heaviest boring and milling work. The spindle is 9½ in. in diameter, has a traverse of 72 in. and a range of speeds from 1 to 50 r.p.m. It is driven either by face plate gear, to which boring bars and large milling cutters may be bolted, or by a smaller gear. The motor has a wide speed variation and drives through back gears and sliding gears. The counterweighted saddle has a vertical adjustment by power of 8 ft., and the column a traverse of 12 ft. on the bed. Both the saddle and column have power milling feeds with automatic stops and quick power traverse. The spindle, saddle and column feeds may be changed or reversed, the quick traverse of the saddle or column may be controlled, and the spindle may be started, stopped or its direction of rotation reversed, all from the operator's platform, which is attached to the saddle. The machine is self-contained in that the motor and all the driving gear move with the column. The bed may be of any length. The main driving motor is of 30 hp capacity at 250 volts and is designed to be used on the three-wire, multiple-voltage system of 90, 160 and 250 volts, giving a speed range of 200 to 800 r.p.m. The motor for power traverse of the circular table and of the table base is of 6 hp capacity and is a constant-speed motor. Current is supplied for driving these motors and others in the same exhibit from the exciter of the 5,000-hp Allis-Chalmers-Bullock unit.

A large number of Westinghouse motors, Figs. 2 and 5, both direct and alternating current, have been applied to various hoists, pumps

and machine tools in the Palaces of Electricity and Machinery, all of which are operating. A Niles Tool Works 40-in. vertical drill is belted to a Westinghouse type "S" 3¼-hp, variable-speed shunt motor. The motor is designed to operate on three-wire, 220-110-volt circuits with a wide range of speed, 325 to 1,300 r.p.m., corresponding to the ratio of the lowest to the highest speed of 4 to 1. A drum type controller is provided giving 15 distinct speeds forward and 6 speeds on reverse. Field resistances of the compact embedded type are placed under the controller, both the resistance and the controller being fastened to a strong vertical board besides the tool drill press. This set is remarkable for its simplicity, the whole speed variation being attained electrically and there being no cumbersome variable-speed gears or step pulleys.

A Pond Machine Tool Company's 36-in. by 17-ft. lathe is driven by a direct-current, variable-speed, 5-hp motor, which is operated on a 200-110-volt, three-wire circuit with a range of speed from 390 to 1,450 r.p.m. The motor is placed on the frame of the tool and connected to it by a noiseless chain. This kind of a drive has the advantage of a belt transmission for higher speeds at the same time not requiring any tension or certain minimum distance between the shafts. A drum type controller is mounted on a side of the frame of the machine and is operated by a long shaft and gears from the slide rest of the lathe, so that the machinist can regulate the speed, keeping close watch on the piece machined. The controller gives 12 speeds forward and 8 on reverse. Field resistance is mounted on the back side of the frame of the machine.

A Fay & Egan band "self-feed" ripsaw is driven by a Westinghouse direct-current, 7-hp, 220-volt compound-wound motor; the speed of the motor at full load being 660 r.p.m. The motor is placed

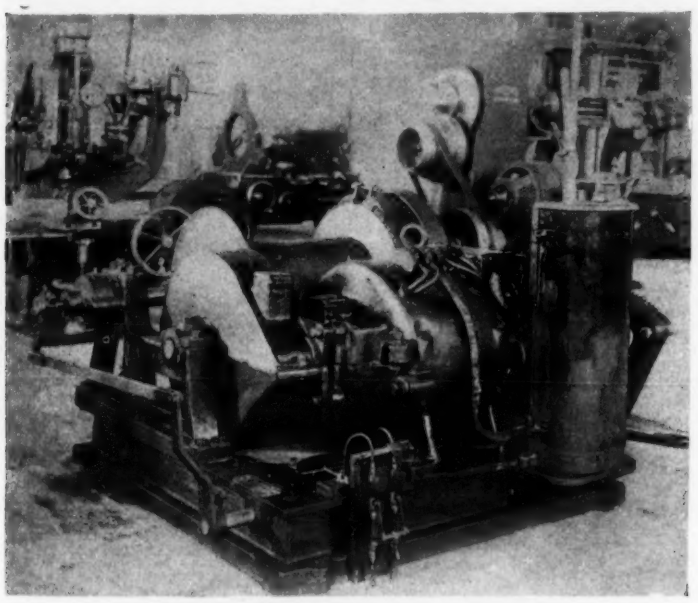


FIG. 2.—ELECTRIC HOIST EQUIPPED WITH WESTINGHOUSE MOTOR AND CONTROLLER.

on the floor and direct-connected to the lower pulley of the saw. The motion of the speed is transmitted from the same shaft through a belt and reducing gears. A starting box for the motor is placed on the frame of the saw and provided with a minimum and maximum release, automatically protecting the motor in case of a failure of the line or of an overload.

A Lidgerwood hoist, as may be seen in the foreground of Fig. 2, is operated by a 220-volt, direct-current, series-wound Westinghouse motor. The motor has a nominal rating of 25 hp and is entirely enclosed like a street car motor. The type of resistance here used is known as the "ventilated cell," consisting of metal strap wound with mica insulation, which can be advantageously used where economy in space and in weight is of importance.

A Newton Machine Tool Works' combination cold saw for metal work, shown in Fig. 5, is driven by a constant-speed, 5-hp, 220-volt induction motor, speed 710 r.p.m. The motor is placed on the frame of the saw and geared to the longitudinal shaft from which the cutter is operated. A constant-speed motor is used in this case because the saw itself is provided with a mechanical variable-feed arrangement. The Newton 12-in. stroke slotting machine, illustrated, is connected to a 3-hp, 220-volt, variable-speed motor; the total range of speed is between 580 and 1,160 r.p.m. This set represents a combination of mechanical and electric means for speed control; the motor is geared to a countershaft which drives the machine by means of conical pulleys; at the same time the motor is provided with field control. This gives a wide range of speed on usual two-wire circuits. The shape of the frame of the slotter permits the motor with its countershaft to be conveniently fastened to it, so as to make the

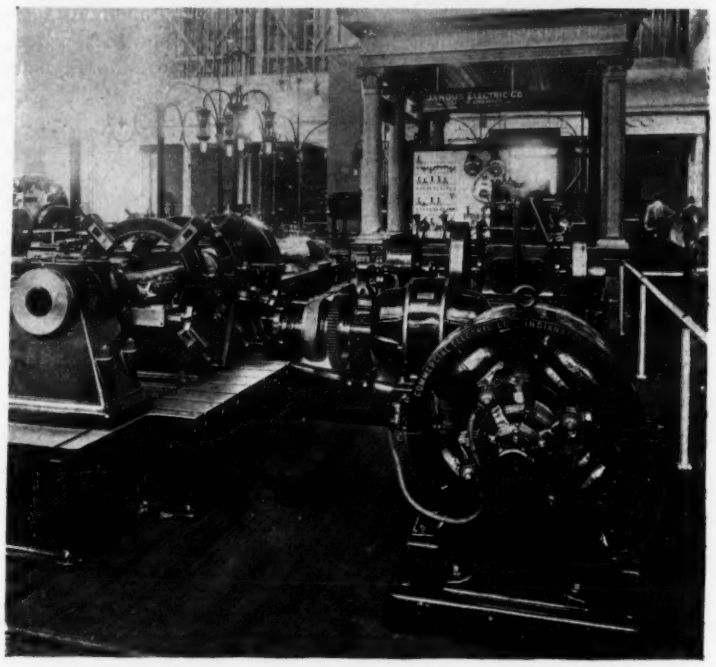


FIG. 3.—COMMERCIAL MOTOR GEARED TO BORING MACHINE.

whole set self-contained. The controller is of the drum type and gives 8 speeds forward and 4 on reverse. The field resistance is bolted to its base and the whole securely mounted on a vertical board permitting the machinist to conveniently watch the cut at the same time regulating the speed of the motor.

In the Westinghouse exhibit in the Palace of Electricity a number of tools are in operation. Among others is a Cincinnati milling machine connected to a 3½-hp, variable-speed, 220-volt motor, having a range from 750 to 1,875 r.p.m. An automatic saw sharpener, of Newton make, is a simple high-speed grinding stone machine, conveniently driven by a belt from a small Westinghouse motor, placed on the floor. The motor is a direct-current, 2-hp, 220-volt

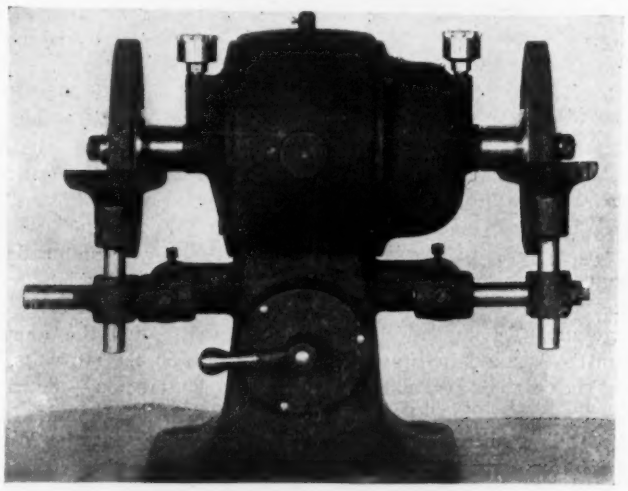


FIG. 4.—PORTABLE BENCH GRINDER.

running at 1,200 r.p.m. A Gould & Eberhardt 34-in. shaper is driven by a Westinghouse variable-speed motor, which is fastened on the back of the frame and connected to the machine by a noiseless chain. The controller is placed horizontally on the side of the frame to fit the general form of the machine and to enable the machinist to vary the speed while watching the cut.

There are some cases in which it is convenient to place the motor on a wall or to suspend it from the ceiling where it would be out

of the way of the workman or other machinery. To demonstrate the adaptability of standard Westinghouse motors to this kind of work three type "S" motors are shown suspended from a large wooden frame in horizontal and inclined positions. Any workman can make the necessary change in any standard Westinghouse motor by unscrewing the end brackets and shifting them so as to have the oil wells in the lowest position. In all other respects the motor is absolutely indifferent as to its position in space. In some special

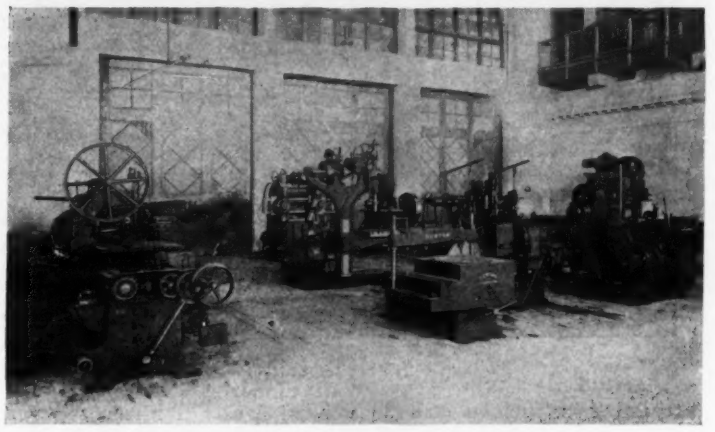


FIG. 5.—TOOLS DRIVEN BY WESTINGHOUSE MOTORS.

cases it is of an advantage to have the shaft of the motor vertical so as to avoid beveled gears or complicated belting. A vertical shaft Westinghouse motor is exhibited on the top of the above frame. It has the standard general construction and a special type of bearings taking up the weight of the shaft in the longitudinal direction.

In Fig. 3 is shown a Commercial variable-speed motor geared to a Barrett boring machine. The motor is of 7½ hp and operates on a two-wire, 220-volt circuit, the speed varying from 350 to 1,300 r.p.m. This variation is accomplished by a field resistance and the double commutator system developed by the Commercial Electric Company.

Grinders were probably the first tools to which the motor became an integral part, for the speeds available and desired are the same, and no gears or other medium were necessary between the motive power and the work. These machines, built in many sizes and for every kind of grinding, polishing and buffing, are on exhibition in

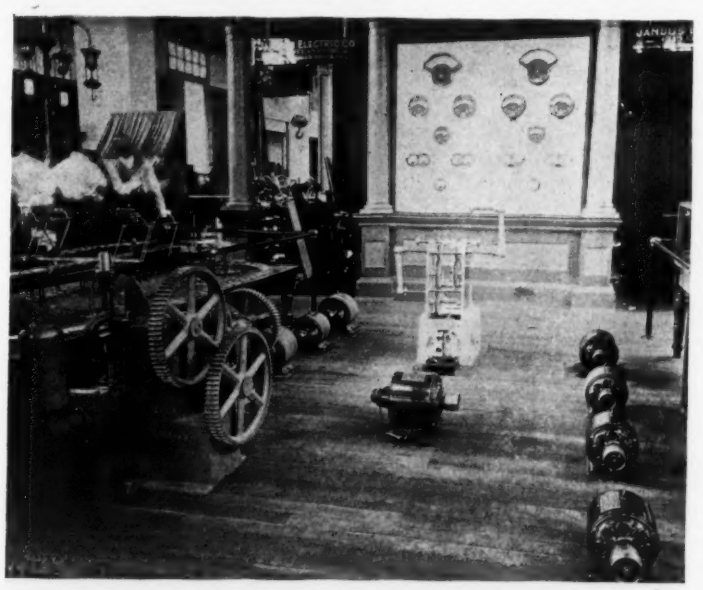


FIG. 6.—STERLING MOTORS AND TAFFY PULLER.

the Electricity, Machinery and other buildings. An excellent specimen of this machine is a portable bench grinder, shown in the illustration and made by Jac. Clark, Jr., & Co. The machine, Fig. 4, carries two 8 x ¾-in. emery wheels and weighs but 110 pounds. The motor is wholly enclosed with self-feeding carbon brushes and self-oiling bearings. The large spindle forming the armature shaft and carrying the wheels is 17½ in. long. The width of the tool is 12 in. and the height 16 in. It can be readily moved to any location where the electric mains can be tapped and is, therefore, a handy adjunct to any machine shop.

The electric motor is now used for many different power purposes, but occasionally an application is made that is out of the ordinary. Taffy pulling is one of the delights of childhood, and the use of machinery for that seems out of place. The illustration shows, however, a motor-driven, duplex taffy pulling machine. In the base is located a Sterling motor, which rotates the arms through a train of gears. The five standard sizes of motors built by the Sterling Electric Motor Company are in the picture, Fig. 6. This company confines its line to small motors from 1/16 to 1 hp, but manufactures these in large quantities. At the left of the picture may be seen one of these motors geared to a Lucas pump.

The adaptation of single-phase motors to various power purposes is exhibited by the Wagner Electric Company, and these can be used wherever a supply of single or polyphase current is available. The motor is applicable except where frequent starting and stopping or where wide speed variation is desired. It is of the induction type and can be operated upon a single-phase, alternating-current circuit or upon any one phase of a polyphase circuit. A single pair of wires furnishes power to the motor and if the voltage is to be reduced,

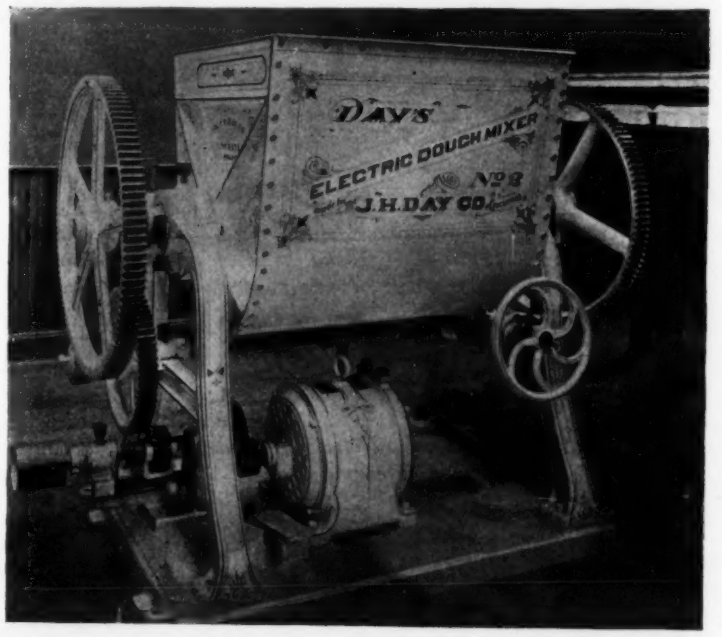


FIG. 7.—WAGNER SINGLE-PHASE, ALTERNATING-CURRENT MOTOR, GEARED TO DOUGH MIXER.

but one transformer is used. No starting box or any other auxiliary device is required. The attendant simply closes the main line switch and the motor takes care of itself. The application illustrated, Fig. 7, is to a dough mixer for large bakeries. The cost to drive a mixer by electric motor is very small—not one-tenth as much as the wages of a man to mix the dough by hand, and the work is done more thoroughly and uniformly. This set is in operating condition with the exception of the dough.

Baltimore Electric Power Company.

The Baltimore Electric Power Company, Baltimore, has been incorporated with a capital stock of $2,500,000 for the purpose of constructing an electric power and light plant for the Maryland Telephone & Telegraph Company. The new company is authorized to issue $7,500,000 bonds. The incorporators of the company are: John T. Stone, president of the Maryland Casualty Company; David E. Evans, president of the Maryland Telephone Company; Henry W. Webb, vice-president and general manager of the Maryland Telephone Company; Robert F. Bonsal and William P. Spring, treasurer and auditor, respectively, of the Maryland Telephone Company. The immediate cause for the organization of the Baltimore Electric Power Company was the application of Alexander Brown, a large stockholder in the Maryland Telephone & Telegraph Company and in the United Electric Light & Power Company, of Baltimore, for an injunction to prevent the former company from engaging in the supplying of electric light and power, on the ground that it did not possess the necessary charter rights.

Miscellaneous Exhibits in Electricity Building at St. Louis.

The Purdue Electrical Research Laboratory has prepared and exhibited a very creditable exhibit of apparatus which has been developed there for research work. The photometers both for arc and incandescent lamps designed by Prof. C. P. Matthews are shown.

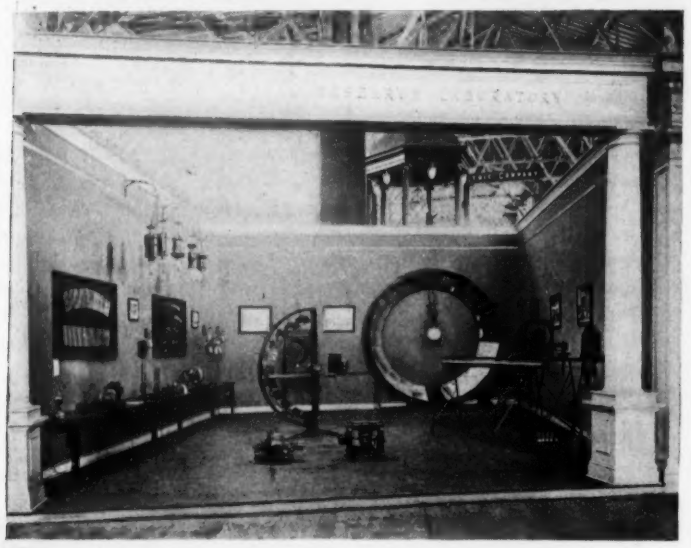


FIG. 1.—PURDUE ELECTRICAL LABORATORY APPARATUS.

There is an electric dynamometer for instantaneous readings developed by Prof. W. E. Goldsborough and several pieces of apparatus for investigating the magnetic properties of metals which have been built by Prof. J. W. Esterline. It is interesting to note that 451 students have matriculated this fall in the School of Electrical Engineering at Purdue University, which is a greater number than attended any other school of like nature in this country.

The exhibit of the Underwriters' Laboratories consists of a large wall case in which are mounted various electrical fittings and appliances that from defective construction or insulation have caused

FIG. 2.—UNDERWRITERS' LABORATORY ELECTRICAL BURNOUTS.

electrical burn-outs, fires resulting in some cases. The display illustrates the hazards involved in the defective construction and installation of electrical apparatus, and shows that a large majority of the fires caused by electricity have been due to violations of the standard for electrical construction as given in the National Electrical Code of Rules.

The interior illumination of the Electricity Building is greatly enhanced by the electric signs, most of these being changeable and operated by automatic switches. The Reynolds Electric Flasher Company has supplied all these switches, which consist of a series of rings or segments, operated by a small motor and stationary contacts. The form of these flashers may be seen by the sign mechanism at the booth of the Holophane Glass Company.

In the Italian electrical exhibit the indicating, recording and in-

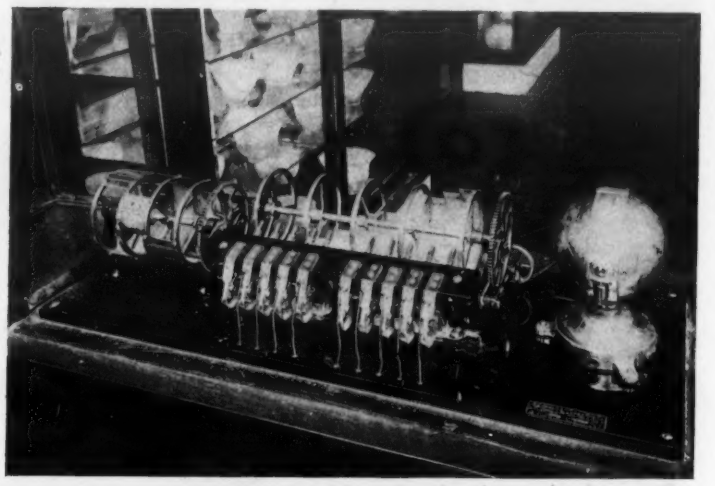


FIG. 3.—REYNOLDS SIGN FLASHER.

tegrating instruments made by Olivetti & Co., of Milan, are worthy of special attention. The historical collection of early apparatus

FIG. 4.—ITALIAN ELECTRICAL EXHIBIT.

used by Volta, Belli, Ferraris and Pacinotti shows at a glance the wonderful development and refinement in electrical mechanism made during the span of a generation. A full line of wires and cables for all electrical purposes are exhibited by Pirelli & Co., of Milan.

The laboratory of the Bureau of Standards was installed with the double purpose of exemplifying the methods and equipment of the bureau as maintained and operated by the Government at Wash-

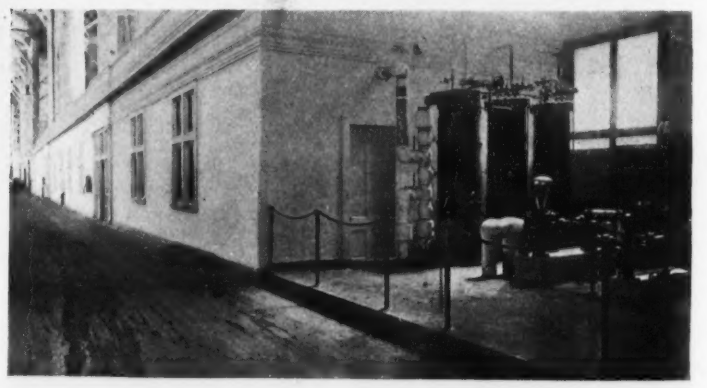


FIG. 5.—NATIONAL BUREAU OF STANDARDS.

ington, and of affording an opportunity of making accurate tests and calibrations upon such apparatus as should be submitted by the Juries of Award. The work of calibrating ammeters, voltmeters and wattmeters, of determining temperature coefficients, and of

measuring resistances, inductances and capacities, was carried on by a force of about twenty-five men from the laboratory in Washington. A large part of the bureau's equipment for work of this character was brought to St. Louis and this was supplemented and in part duplicated by various American instrument makers.

A large number of tests were made, not only for the Jury of Award and for the Electric Railway Test Commission, but also for various exhibitors and others who availed themselves of the opportunity to have their instruments compared with the standards of the bureau. In addition a certain amount of research work was also carried on in lines which had been interrupted by the removal of the apparatus from Washington. Unusually good conditions for such work were furnished by the installation of a ten-ton refrigerating machine and a system of ventilation and automatic temperature control for the entire laboratory.

The Waite & Bartlett Manufacturing Company has a fine exhibit of electrotherapeutic apparatus, including static machines, cabinets.

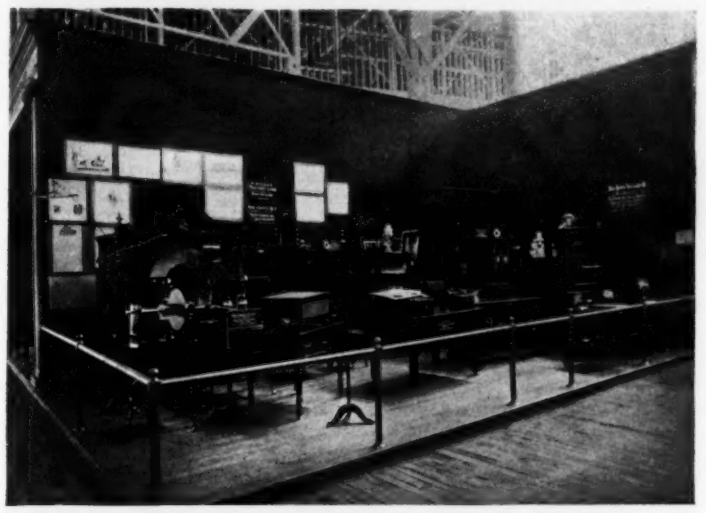


FIG. 6.—WAITE AND BARTLETT ELECTROTHERAPEUTIC APPARATUS.

Crookes tubes and other electrical appliances used in diagnosis and treatment. This exhibit as well as others of like nature has been of great interest to visitors, for there are comparatively few who understand how extensively electrical treatments and movements are utilized for the alleviation of disease.

The Leclanché Battery Company has an exhibit in the Electricity

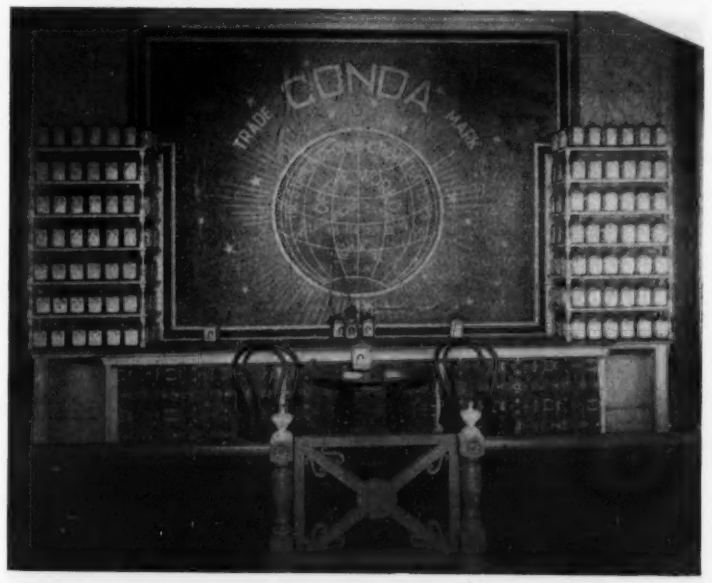


FIG. 7.—LECLANCHÉ PRIMARY BATTERIES.

Building showing the different type of batteries made by this company. These include the Gonda porous cup cell, the Axo cell, the Gonda and Wedge cells, the latter having the gondas and carbons so arranged as to form a good contact at all times and effectually preventing the danger of short-circuiting.

Combination Switch and Plug Cut-Outs.

A new line of combination switch and plug cut-outs just placed on the market by H. T. Paiste Co., of Philadelphia, are called "P-K" panel cut-outs. These comprise 25 and 30-amp. mains for 125 and

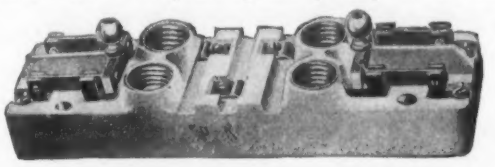


FIG. 1.—SWITCH AND CUT-OUTS.

250-volt circuits, and single and double branches for both two and three-wire circuits. In addition to the six styles of cut-outs in this line, the firm furnishes complete wooden panel boxes and oak fronts

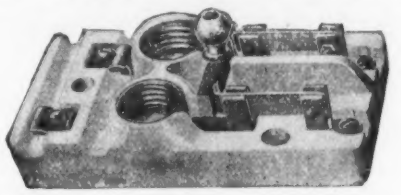


FIG. 2.—SWITCH AND CUT-OUTS.

with quartered oak doors for same. These wooden boxes are lined throughout with ⅛-in. asbestos board and are ready for setting in the studding. The fronts are mill finished, smooth, ready for var-

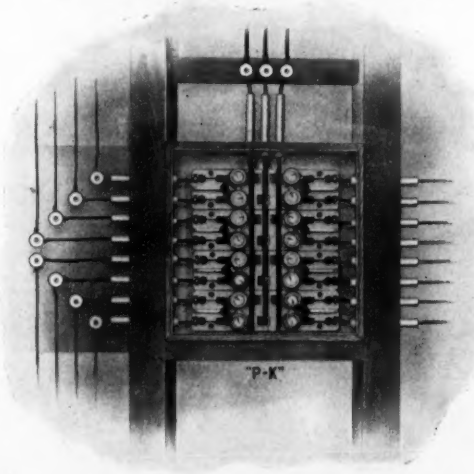


FIG. 3.—PANEL.

nishing or painting and are complete with hinges, rim lock and key. This is an entirely new and unique line, as heretofore the wireman has had a carpenter build his box, line it with two or three thick-

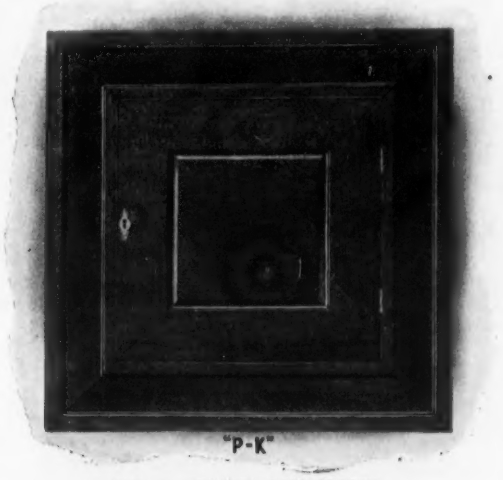


FIG. 4.—PANEL BOX CLOSED.

nesses of asbestos cloth to bring it up to the required ⅛ in. and finally get a mill to make the fronts.

With this line of material at his service the wireman can build his own panel boards of any number of circuits. The material is all approved by the National Board of Fire Underwriters.

The Silent Chain for Driving Machinery.

The Morse Chain Company, Trumansburg, N. Y., has as a result of a thorough and exhaustive investigation, perfected a chain for machinery driving which is claimed to be adaptable to any class of service whatever, is not affected by high speed, very hot or dry atmosphere or moisture and will run satisfactorily with but little lubrication, which in practice will not wear rapidly even when subjected to the most severe extremes imaginable of dust, dirt and grit, and which has an efficiency in transmission of power, as shown by actual test, from 98½ to 99 per cent.

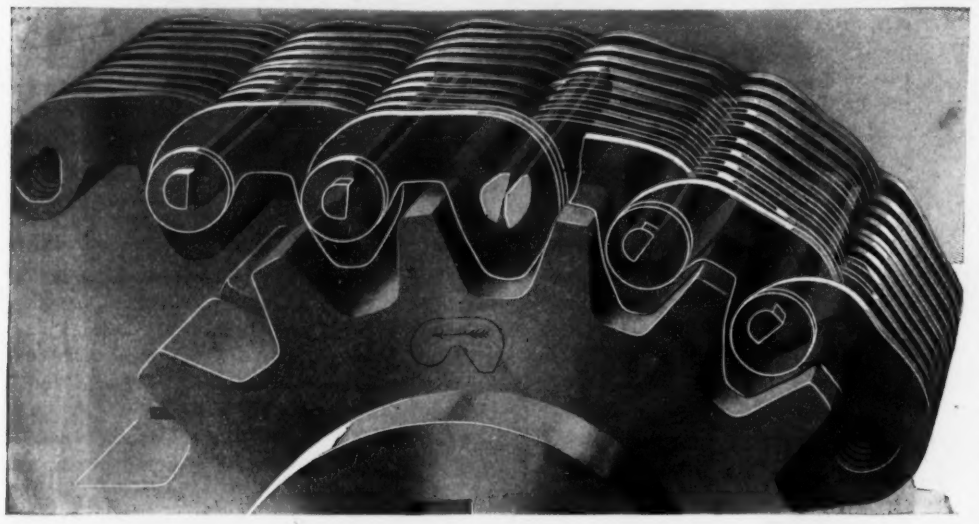


FIG. 1.—SHOWING CONSTRUCTION OF CHAIN.

The construction of the Morse silent chain is shown in Fig. 1. The joint consists of two pieces of hardened tool steel, so shaped and arranged that, as the joint works while passing on and off the sprockets, one piece rocks or rolls on the other. The two rocking parts of the joint are fixed in opposite ends of the links, and as there is only a pure rolling friction on hardened tool steel surfaces with ample contact area to withstand the pressure, there is no tendency for the joint to wear and cause the chain to lengthen. To prevent undue vibration under high speeds and the consequent wear, the rocker pins are so shaped that the areas of contact surface are greatly increased when the chain is drawn straight between sprockets, in which position a broad bearing is given. The two-part pin used in the Morse rocker joint permits of an unbroken contact the whole width of the chain, less the outside links, which results in nearly doubling the length of the bearing surface over a chain with a single-pin joint.

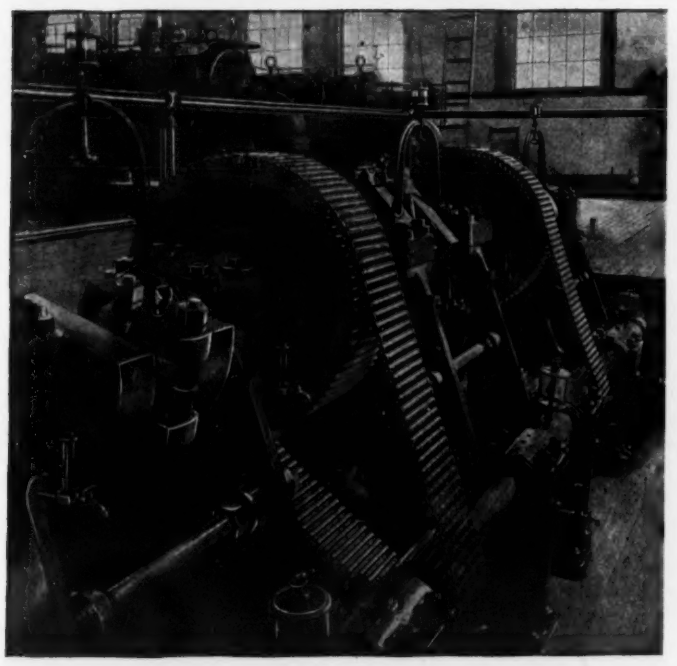


FIG. 2.—CHAIN DRIVES.

As the rocker joint is subjected only to rolling friction it does not require lubrication, and the speed limit is, therefore, not fixed by the point at which the centrifugal force will throw off the lubricant. A paste grease, sufficiently heavy, so that it will not be thrown off at high speeds, affords proper lubrication for the chain in its contact with the sprocket teeth and between the plates of the chain itself. As the pressure between the chain and the sprocket teeth is inversely proportional to the number of teeth in contact with the chain, and as this number is large, the pressure is small, and very little wear will take place.

The life of a silent chain is inversely proportional to the number of teeth in the large sprocket, and since the lengthening of the Morse chain is very slight it is possible to use very large sprockets and make large speed reductions. The relation of the size of the wheel to the life of the chain (this being the principal feature that makes it silent) comes from the fact that the chain climbs higher on the tooth as it lengthens and does not become inoperative until the top of the tooth is reached. The height of the tooth for a given pitch is practically the same for all sized wheels, and it follows that in a unit length of chain, equal to the circumference of any wheel, the total lengthening that may take place before the top of the tooth is reached is the circumference of a circle whose radius is the height of the tooth. The amount of stretch, therefore, that can take place per link in this length of chain is inversely proportional to the number of teeth in the wheel, which equals the number of links in the chain. It is for this reason that with a chain having the less lengthening due to wear, the greater is the number of teeth that can be satisfactorily used in the large wheel, with a consequent larger speed ratio.

The sprocket wheels are made of cast iron, accurately cut, and in use are found to show little or no wear. For exceptionally hard service or when there is little metal around the shaft, hardened steel sprockets are used. To guide the chair properly, special guiding links are used, projecting below the balance of the chain into grooves turned in the sprockets. The holes in the opposite ends of the links are punched to conform in shape to and securely hold, in the large end of the link, the rocker pin, and in the small end, the seat pin, there being no motion between either part of the joint pin and link.

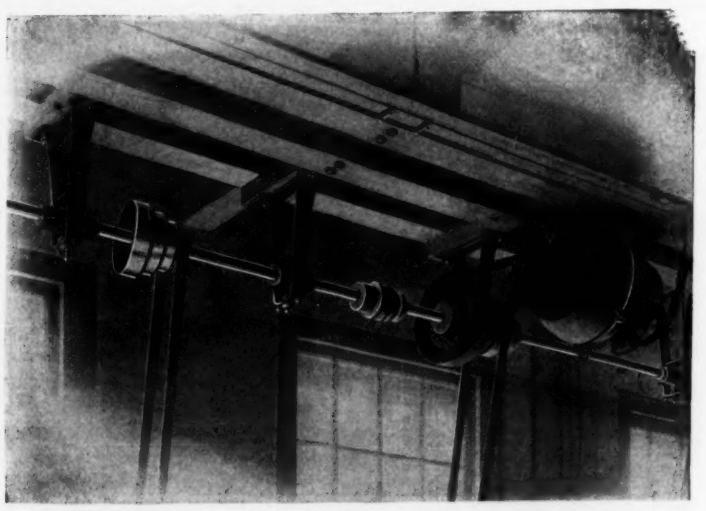


FIG. 3.—7½-HP MOTOR CHAIN DRIVE.

The outside links are bent laterally, so that the large end comes under the small end of the adjoining link to permit of the proper engagement with both seat and rocker pin. The joint pins are made of the best grade of tool steel carefully hardened, the shouldered ends of the seat pins being softened to permit of being riveted in the outside links, or in washers in the larger pitches, to securely hold the chain together.

Fig. 2 showing two chain drives, operating from a motor-driven shaft to drive condensing pumps, illustrates the use of the positive and noiseless drive under conditions where a belt could not possibly

be used. These chains were introduced here to replace the gears formerly used, on account of their noisy action. The maximum pull on the chain is 10,000 pounds, which alternates to 300 pounds negative pull at each stroke, due to the intermittent action of the pumps, but over two years' service shows no depreciation. Fig. 3 shows a ceiling drive from a 7½-hp motor to a line shaft, where the chain speed

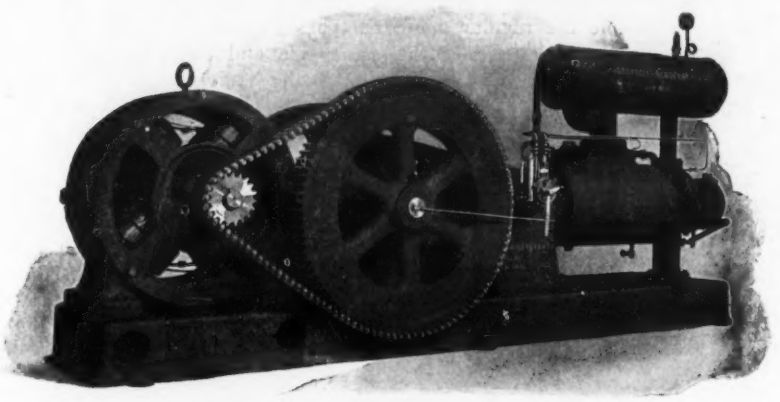


FIG. 4.—40-HP MOTOR-DRIVEN AIR COMPRESSOR.

is 850 ft. per minute. The compactness and convenience of this arrangement is an interesting features. Fig. 4 shows a motor-driven air compressor, illustrating the use of the Morse chain for the driving of the air compressors for the storage air brake system of the St. Louis Transit Company. The motor is in this case of 40 hp capacity and the chain speed reaches as high as 1,090 ft. per minute. It operates noiselessly and its compactness is one of its most valuable features.

Electrical Holiday Gifts.

No more modern or acceptable article could be selected for young people than one of the electrical novelties now on the market in great variety, and a few of which are here illustrated. The interest in such toys is a proof of the general desire to acquire information about electricity.

The model coal mining railway is complete in itself and consists of a powerful miniature electric locomotive and three automatic

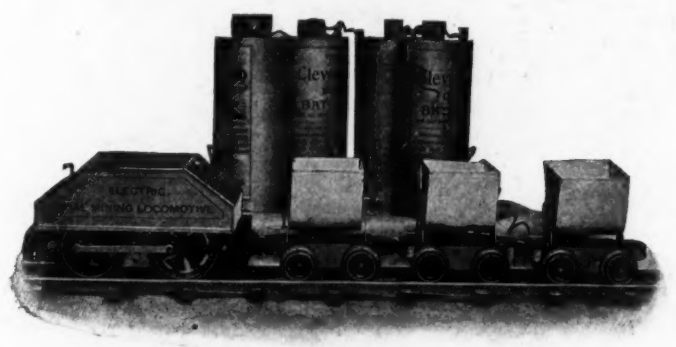


FIG. 1.—MINE LOCOMOTIVE.

dump cars, 18 ft. of steel track and four dry batteries. Motive power is furnished by a small electric motor on the locomotive, current for which is conducted through the rails of the track. The locomotive is sufficiently powerful to haul ten or twelve loaded cars and will climb heavy grades and pass around sharp curves.

A more complete outfit consists of a miniature locomotive and tender, five freight cars and a caboose. Track, switches and bridges are included, also batteries. The locomotive has a reversing switch and may be stopped, started or backed at will of the operator. It is a never-ending source of pleasure and is often as much appreciated by the grown people in a family as it is by the children. A large variety of other cars are offered and may be substituted or added to the equipment as desired. A very novel car is the derrick type, which has an electric motor for operating the crane. It will lift weights of several pounds. It is, in general design, a close copy in miniature of the well-known steam railroad wrecking outfit.

For those of a more investigating turn of mind, who wish to construct model dynamos and motors, complete sets of finished castings with the wire, etc., are furnished from which perfect working

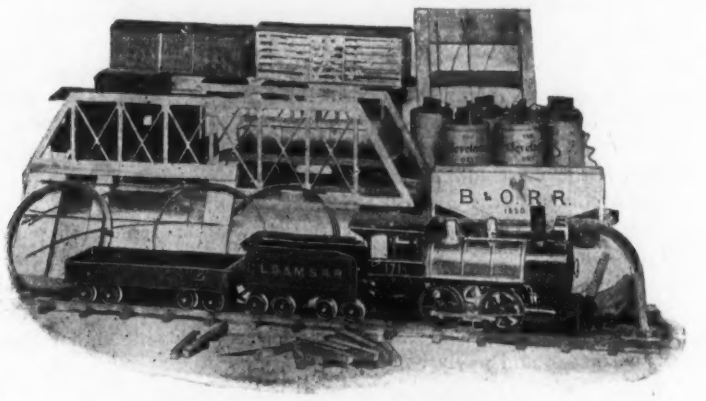


FIG. 2.—MINIATURE LOCOMOTIVE, ETC.

dynamos and motors may be constructed. In addition to the finished castings, sets of gas or gasoline engine castings are sold in the

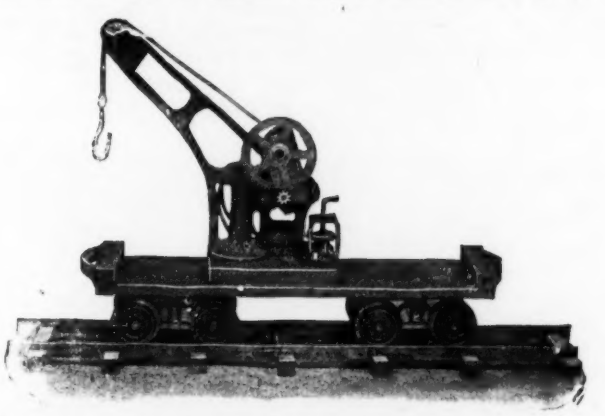


FIG. 3.—DERRICK CAR.

rough which may be worked up into practical working engines, capable of running lathes, dynamos and a variety of light machinery.

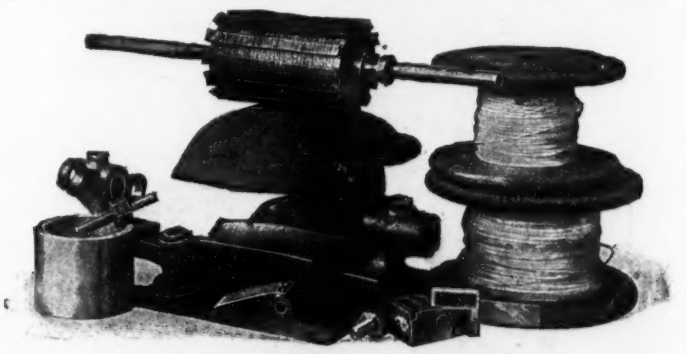


FIG. 3.—CONSTRUCTION PARTS.

The Carlisle & Finch Company, 228 E. Clifton Avenue, Cincinnati, Ohio, is the manufacturer of this apparatus, which, no doubt, will prove to be attractive novelties at this time of the year.

An Electrical "Wonderworld" for New York.

Encouraged by the success of the great popular resorts at Coney Island, some enterprising capitalists propose to duplicate and eclipse such places as "Luna Park" and "Dreamland" with a new center of electrical display and spectacle at the other, northern, end of Manhattan. One of the troubles with Coney Island is that while it enjoys ocean breezes its season begins so late and ends so early. Hence,

the burden on the investment is severe; besides, no winter spectacles are possible. The new attraction, "Wonderworld," will be situated on the south bank of the Harlem River, at Two Hundred and Eighteenth Street, where it will be readily accessible. An Interborough station will be in "Wonderworld" itself, and the Kingsbridge Station on the main line of the New York Central is just across the Harlem River. Moreover, the boats that ply on the Hudson River can float in through the Harlem and dock directly at the park. Mr. Andrew J. Cobe, promoter of the enterprise, has awarded the contract of construction to the Wells Brothers Company, and the contract for electrical work to Harry Alexander. The total cost involved will be nearly $2,000,000. Mr. Cobe expects to have the new "Wonderworld" ready for the opening of the summer season in Manhattan, if the necessary capital is raised.

The architects, Kirby, Pettit & Green, have striven to make "Wonderworld" a place very different from all other recreation parks. Electrical effects and illuminations will catch the eye in every direction. "Wonderworld" will occupy thirty-one acres. The "esplanade walk"—a kind of midway—will run through the middle of it. There are to be a German village, a Japanese village, a sixteenth century German castle and gayly colored pagodas.

Within "Wonderworld's" boundaries is the old Dyckman Mansion, which will be turned into a mammoth ballroom and casino. Between the mansion and the "esplanade walk," where now is a thick grove of trees, will be gardens laid out with curving paths and rustic benches. The natural characteristics of the grove will be interfered with as little as possible.

The residents of the Bronx and suburban towns, such as Yonkers and New Rochelle, who take over two hours to get to Coney Island, will be able to reach "Wonderworld" in fifteen minutes. The Subway, the New York Central Railroad and the Hudson River boat lines all meet there. Even districts at the southern end of Manhattan Island will be comparatively near to "Wonderworld" in point of time. This stretch of the Harlem River, usually called the Harlem Ship Canal, was improved by the United States Government at an expense of $5,000,000 a few years ago, and is deep enough to admit large boats. The work is to be prosecuted all winter and the resort will be ready by next summer, if these plans go through.

Bogia Regulating Socket.

The accompanying illustration shows a regulating socket being placed on the market by Louis A. Bogia, Jr., 146 North Seventh Street, Philadelphia. Any commercial type of incandescent lamp

REGULATING SOCKET.

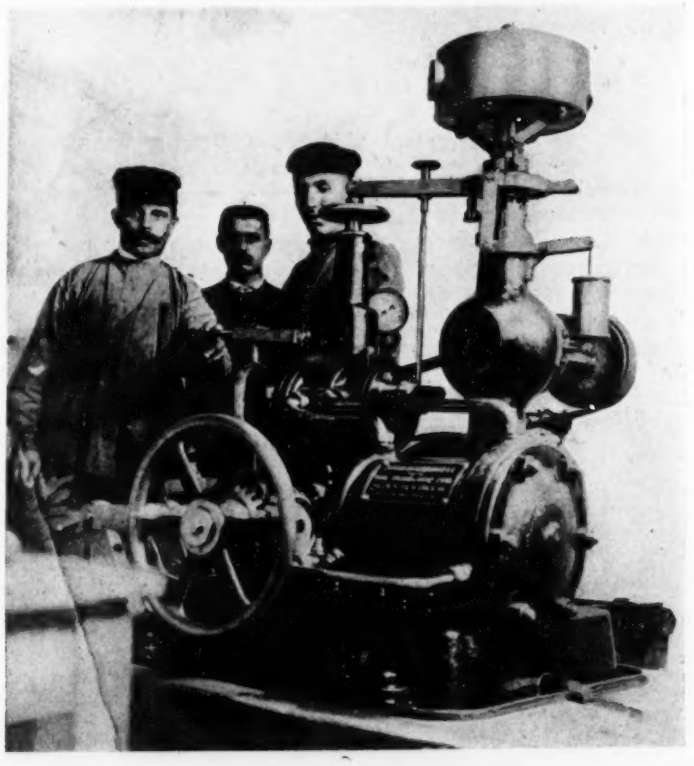
may be used with this socket, which is also made as a receptacle. Its function is to enable the candle-power of a lamp to be dimmed from full candle-power down to darkness, with a considerable saving in the consumption of current when dimmed. The candle-power is not reduced in step divisions, nor by the use of separate filaments in the lamps, but it is accomplished gradually by simply turning the key of the holder. No combustible material enters into the construction of the holders, which are thus absolutely fire-proof. The resistance material used is thoroughly imbedded in porcelain, which protects the resistance medium from injury or disarrangement, and isolates the heat considerably.

The holders will dim 4, 8 and 16-cp lamps for 110-volt, constant-potential circuits in one type, and the same in candle-powers for 52 volts in another type. They will also reduce the speed of portable fan motors and regulate small electric heating apparatus, etc. The holders resemble the regular standard types of sockets and receptacles, as they are practically the same size and have a similar appearance. The light may be dimmed to the equivalent of a low turned gas jet (½ cp). Approximately 67 per cent. of the current consumption is saved when the lamp is fully dimmed. The holders may be used and are interchangeable on direct or alternating-current (constant-potential) circuits.

A European Hydraulic Governor.

THE accompanying illustration shows a type of hydraulic governor made by Ruston, of Prague, Bohemia, for which a number of claims for superiority are made. The governor shown is rated at 7,000 pounds, and the type is also made with ratings from 3,000 to 20,000 pounds. It is claimed that the governor uses normally only from one-sixth to one-tenth of the power of other hydraulic governors, that it starts without shocks and regulates to within 2 to 3 per cent. in speed when 85 per cent. of the load is suddenly thrown on or off.

The governor consists essentially of a lower chamber containing oil, which communicates with the interior pump casing of a rotary



HYDRAULIC GOVERNOR.

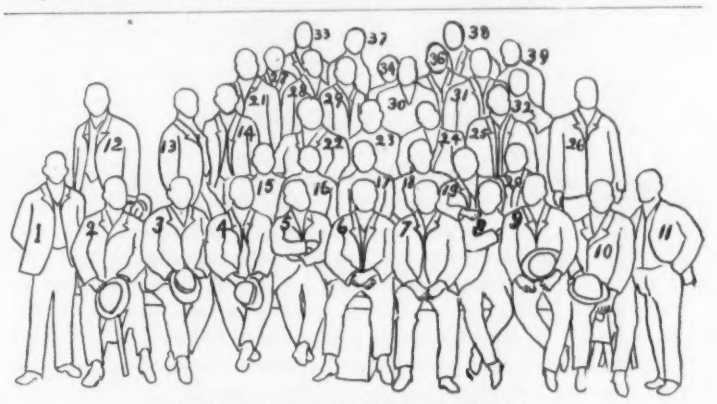
pump having two toothed wheels. The pressure space is connected to a valve case containing a cylindrical slide valve.

The interior of the slide valve communicates with an oil return pipe to the lower chamber. Intermediate to the inlet and center channel are two sets of circumferential exit channels arranged in connection with a working cylinder, containing a piston which has a rod connected by links to the regulating shaft. The latter is attached to the regulating device of the turbine buckets or blades. In order to prevent an over-regulation this shaft is provided with an auxiliary crank, which is also in connection with the lever of the centrifugal governor and the slide valve mentioned, thus stopping the return motion. The governor has no parts which are exposed to a heavy gear. It has a very simple return arrangement for the oil, regulates very exactly, saves in driving power and has a long life.

Meeting of the Westinghouse District Office Managers and Heads of Works Departments.

Several years ago Mr. Frank H. Taylor, vice-president of the Westinghouse Electric & Manufacturing Company, as part of his very successful work in co-operative methods, instituted the annual meetings of the district office managers and the heads of the various works and departments of the company. That these meetings are conducive of great good is self-evident. The men come from all parts of the United States, where different sorts of conditions prevail, and each gives the result of his experience during the preceding year for the benefit of all. A careful analysis of the reports is made by the management, and the information gained plays an important part in the policy of the company and in the guidance of the future effort of its representatives. The managerial policy and the shop practice of the Westinghouse Company have always been notable for their broadness and practical working character, and having been conceived along carefully laid lines, they have been fortunate in having to undergo no radical change. At the same time, change is a condition of development and it is in this spirit that the annual conventions are held and the results made profitable.

Last month the latest annual meeting was held, which was followed by a banquet given by the management to the visiting managers, at which all the executive officers of the company were present. During the meeting a group photograph of the attendants was taken, a reproduction of which is given herewith. As the group comprises a large number of those who are identified in superior capacities with the Westinghouse Company, and many of whose names are widely known, we also give a numbered key to the photograph, together with a list of the corresponding names.



KEY TO GROUP PHOTOGRAPH BELOW.

1. E. W. T. Gray, Manager, Sales Office, New York.
2. D. E. Manson, Manager, Boston Office.
3. C. W. Register, Manager, Cincinnati Office.
4. C. B. Humphrey, Manager, Detail and Supply Department.
5. Chas A. Terry, Secretary and Attorney, New York.
6. F. H. Taylor, Second Vice-President.
7. W. S. Heger, Manager, San Francisco Office.
8. F. B. H. Payne, Manager, Export Office.
9. G. B. Griffin, Assistant Manager, Detail and Supply Department.
10. C. W. Underwood, Manager, Buffalo Office.
20. J. E. Johnston, Manager, Dallas Office.
21. P. N. Jones, Manager, Pittsburg Office.
22. C. S. Cook, Manager, Railway and Lighting Department.
23. W. M. McFarland, Acting Vice-President, East Pittsburg, Pa.
24. C. A. Bragg, Manager, Philadelphia Office.
25. S. J. Keese, Manager, Los Angeles Office.
26. W. F. Fowler, Manager, Baltimore Office.
27. S. E. Webster, Manager, St. Louis Office.
28. S. H. Anderson, Credit Manager, East Pittsburg, Pa.
29. N. S. Braden, Sales Manager, Canadian Westinghouse Co.

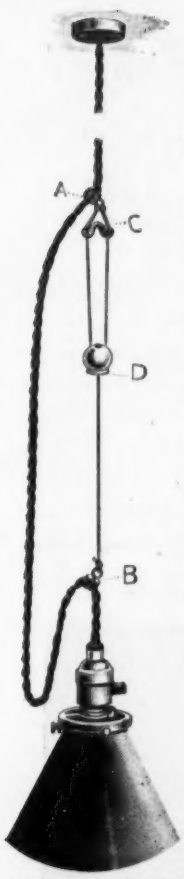
WESTINGHOUSE OFFICE MANAGERS AND HEADS OF DEPARTMENTS.

A feeling of optimism was quite in evidence throughout the convention regarding the business situation and the prospects of continued prosperity all over the country. Messrs. W. S. Heger, of San Francisco, and L. N. Cargo, of Salt Lake City, were enthusiastic as to the prospects in the far West, work being plentiful and money easy. Mr. J. R. Gordon, of Atlanta, Ga., considered that the South will soon have the greatest boom of its history, owing to the large cotton crops of the past two years and the increase in manufacturing. The development of Southern water powers is a promising factor. Mr. F. H. B. Paine, manager of the export department, said that the outlook for foreign business has never been more promising for American manufacturers, because never before were Europeans more alive to the superiority of American manufacturing methods. Pittsburg apparatus, he said, always has the preference because of its superiority. Messrs. C. A. Bragg, of Philadelphia, and E. W. T. Gray, of New York, were both sanguine as to general industrial activity in the East during the coming year. Mr. Bragg said that lack of confidence had disappeared and hopeful buoyancy is every-

11. Chas. F. Medbury, Manager, Detroit Office.
12. J. R. Gordon, Manager, Atlanta, Ga., Office.
13. Calvert Townley, General Agent, New York.
14. M. P. Randolph, Manager, Seattle Office.
15. James C. Bennett, Auditor, East Pittsburg, Pa.
16. S. L. Nicholson, Manager, Industrial and Power Departments, East Pittsburg, Pa.
17. L. A. Osborne, Fourth Vice-President, East Pittsburg, Pa.
18. R. L. Warner, New England Representative, Boston, Mass.
19. Geo. B. Dusinberre, Manager, Cleveland, Ohio.
30. F. L. Shepard, Engineer in Charge of the United Switch Control System.
31. Walter Cary, Manager, Sawyer-Man Electric Company, New York.
32. C. F. Scott, Consulting Engineer, East Pittsburg, Pa.
33. L. M. Cargo, Manager, Salt Lake City Office.
34. G. Pantaleoni, General Southwestern Manager, St. Louis, Mo.
36. F. F. Rohrer, Correspondent, Main Office.
37. T. J. McGill, Manager, Minneapolis Office.
38. J. W. Sterns, Denver Representative.
39. A. Goodby, Correspondent, Main Office.

where observable, while Mr. Gray stated as a foregone conclusion that business will be excellent, as cheap money is abundant and there is no lack of financial support for any legitimate enterprise.

Adjustable Lamp Hangers.



ADJUSTABLE LAMP HANGER.

The latest things out in automatic cord adjusters are the "Innovate" adjustable hangers, in which no springs or weights are used. The inventor, Mr. Fred L. Gregory, of Chicago, has contrived means of producing and employing friction, which retains automatically and at the desired height anything from the smallest bulb to the heaviest lamp fixtures and shades. The "Innovate" is made in two styles; the ball shape beautifully finished in oxidized copper and the watch shape plain finish. Both are practical and perfect in construction, operation and durability. The arrangement is shown in the engraving herewith. When attached at *A* and *B* as indicated, the adjuster is ready for use.

The Innovate Manufacturing Company, 145 Van Buren Street, Chicago, maker of these hangers, enumerates the following points as to the devices: Anyone can attach them in one minute to any hanging lamp cord; they cannot get out of order; they do not wear the insulation; they occupy no available space; only a second is consumed, by a pull or a push of the lamps to any height and they stop just where wanted; the "Innovates" guarantee perfect service and last a lifetime.

Pumping Tar and Other Heavy Liquids.

In many industries it is necessary to force heavy, viscous liquids through pipes. This involves difficulties not encountered in ordinary pumping. Tar, molasses and cocoa liquor present more obstacles to pumping than any other substances which it has been found feasible to move in this manner. Each of these liquids thickens into an almost solid mass when cold, rendering it very difficult to start the pump, if some special provision is not made and ample power provided. Another action which must be taken into account

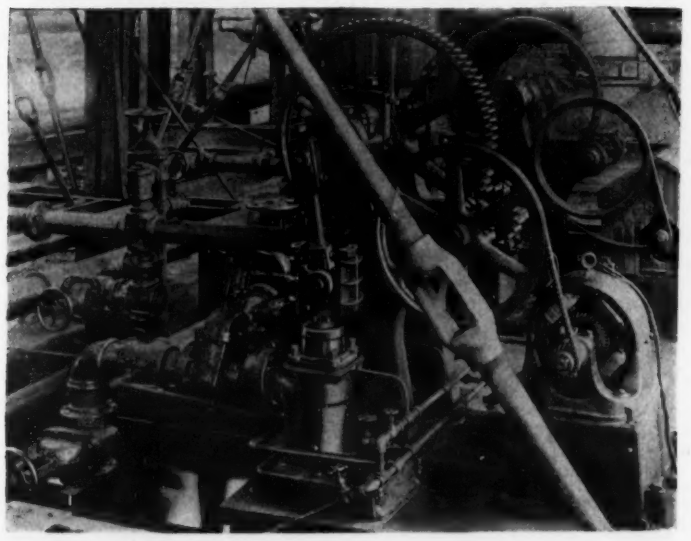


FIG. 1.—PUMP INSTALLATION.

is the contraction of the area of the passages and valves as the liquid cools and the consequent throttling which interferes with the liquid's passage and which the pump is forced to overcome. The skin friction of a liquid of this kind creates heat enough to partially alleviate this tendency to throttling when the velocity of the substance is maintained above a certain point and the pipe is not in such a position that the surrounding air will lower the temperature of the liquid below the solidifying point. Although not a common practice, it is well to lag all exposed piping used for conveying heavy oils or other substances of a similar nature.

Gas tar has a number of characteristics rendering it exceptionally difficult to pump. Its condition varies from a solid to a penetrating fluid within a small range of temperature. Two pumps which have proved very efficient in lifting and forcing gas tar were installed a short time ago at the plant of the Maryland Steel Company, of Sparrows Point, Md. Fig. 1 shows the pumps in position, the one

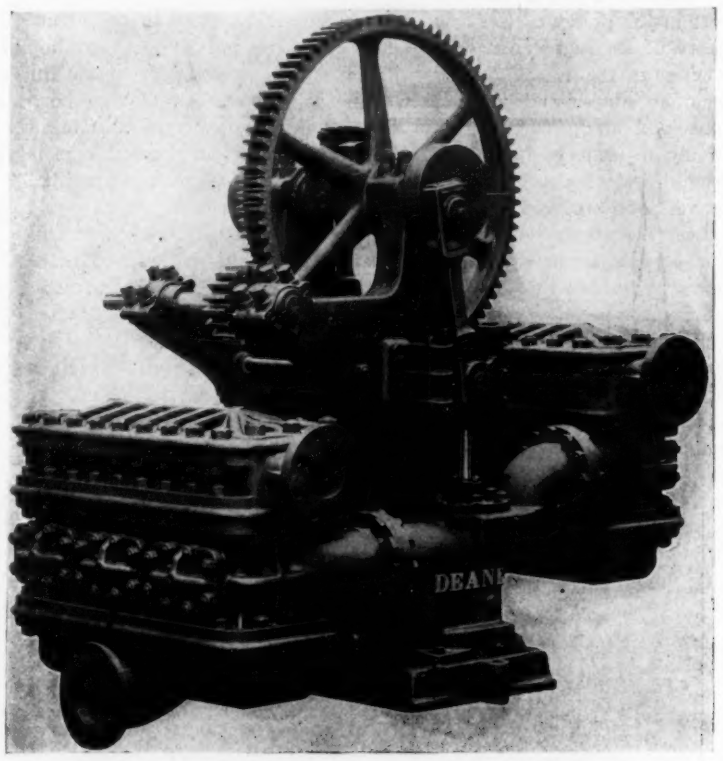


FIG. 2.—TAR PUMP.

in the foreground being idle and the one in the background working under its normal load. They were built by the Deane Steam Pump Company, of Holyoke, Mass., and are of the standard triplex type of that company, fitted with ball valves peculiarly adapted to this service. The exclusive use of gate valves in the piping system is also interesting. A very flexible power connection is obtained by the use of the Renolds silent chain and a four-pole, alternating-current, 3-hp motor. The gearing consists of an 18-tooth pinion running at 950 r.p.m. and a 120-tooth wheel running at 142 r.p.m. The chain used has links ¾ in. wide and 1½ in. long. It transmits the 3 hp generated at 950 ft. per minute, giving an excellent efficiency when the service is considered.

A liquid peculiarly difficult to handle is oil refinery tar, which is usually very hot when it reaches the pump. There is a large percentage of suspended particles of various sizes present in this tar and also a certain amount of unrefined paraffin. The tar is sometimes heated to a temperature of 300°, but quickly cools off if not properly handled, and coats the retaining valves and walls with layers of an adhesive substance closely resembling finely divided particles of coke. To overcome the difficulties the ordinary pump arrangement and design is materially changed.

Fig. 2 shows a specially designed pump installed by the Deane Company for handling oil refinery tar at the works of the Atlantic Refining Company, in Philadelphia. By a new arrangement exceptionally large valve areas are made available, the valves being designed to permit the passage of the substance pumped with the least possible frictional resistance. The suction, discharge and pulsation chambers can be taken apart without unnecessary expenditure of time or labor, and each is in a position where it can be readily reached for cleaning. The pump is of the triplex type, as shown in the figure, and is fitted with ball valves, which thorough test has proved best adapted for the passage of heavy substances. There are a number of large hand holes for cleaning the valves. The figure

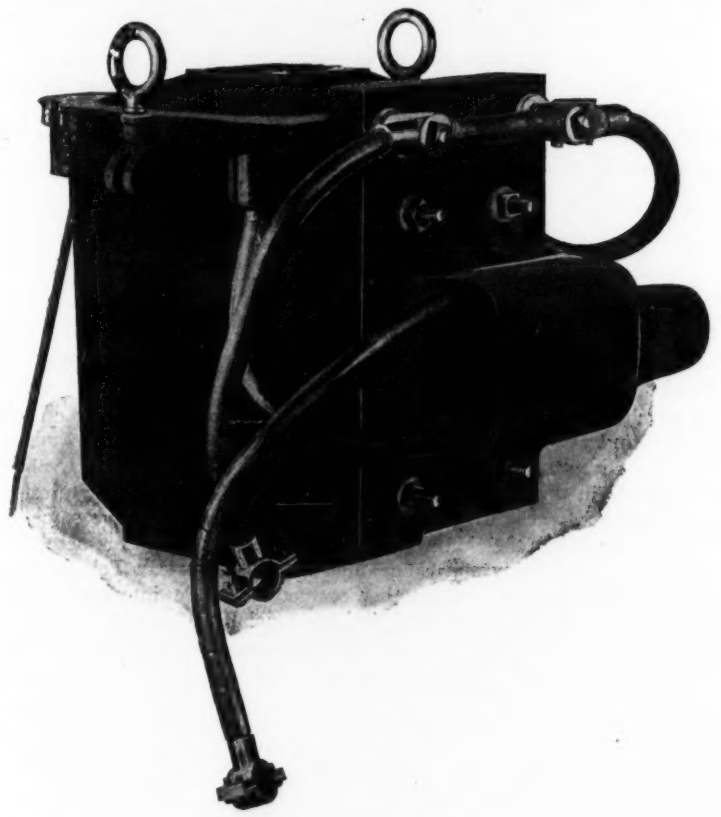
shows the rigid cross head guide system and the strong design of the chambers, rods, pistons and bearings.

Machinery motor driven which will pump these oils and other similar substances can be used in many industries, and will save the laborious processes by which this class of work is generally accomplished.

Apparatus for Thawing Pipes.

At this season of the year there is natural and renewed interest in the subject of thawing out by electricity frozen water pipes, in which a large amount of work has been done by central stations during the past few winters. There is no doubt that in this novel branch of industry an honest penny can be turned by many plants, and a handy, convenient outfit for the work will, therefore, be purchased by them.

The Pittsburg Transformer Company, of Pittsburg, Pa., is now manufacturing a "pipe thawer" outfit which is here illustrated. It weighs only 235 pounds and with its application water will usually begin to flow in five or ten minutes, slowly at first and increasing to normal volume as the ice is melted or washed away in small fragments. The outfit consists of a transformer adapted to operate on any circuit of approximately 1,100 or 2,200 volts and 60 or 133 cycles.



PIPE-THAWING OUTFIT.

The transformer will deliver a current of 300 amp. continuously or currents of about 600 amp. for periods of half an hour. On the back of the transformer are mounted a heat indicator and a choke coil. The heat indicator consists of a section of lead pipe, connected in series with the transformer, and the temperature which this assumes is a guide as to the heating of the pipe under treatment. The choke coil consists of a few turns of heavy copper bar, with a movable laminated iron core. When this plunger is pushed entirely into the coil the transformer secondary may be short-circuited, but no more than normal current will flow. Simple instructions are furnished for operation, one secondary lead being connected to the pipe inside the house and the other lead to a pipe inside a neighboring house or to any nearby hydrant.

Lighting System for Argentina Town.

A municipal electric lighting system will be constructed in Chivolco, an Argentina town of some 7,000 population.

New Motor Speed Controller.

It has long been recognized that the ideal method of constant-potential motor speed control is by variable voltage. The speed of a motor with a constant field is nearly in proportion to the impressed e.m.f., the lack of exact proportion beng due to the fact that the armature IR component of the impressed e.m.f. is constant for a given torque, so that the counter e.m.f., upon which the speed depends, changes at a somewhat different rate than a change in impressed e.m.f. Aside from the advantage of almost constant torque at all speeds for a given work, is the very important one that there is no tendency to sparking throughout the entire range of speed variation. The advantages of this method of control have led to a number of systems for its utilization. Among these is one employing a motor to drive a generator, which latter supplies to the working motor a voltage which is varied by rheostatic control of the generator. Another utilizes a storage battery, and several systems depend upon multivoltage generation and distribution.

To obviate the complication and expense of these systems—all

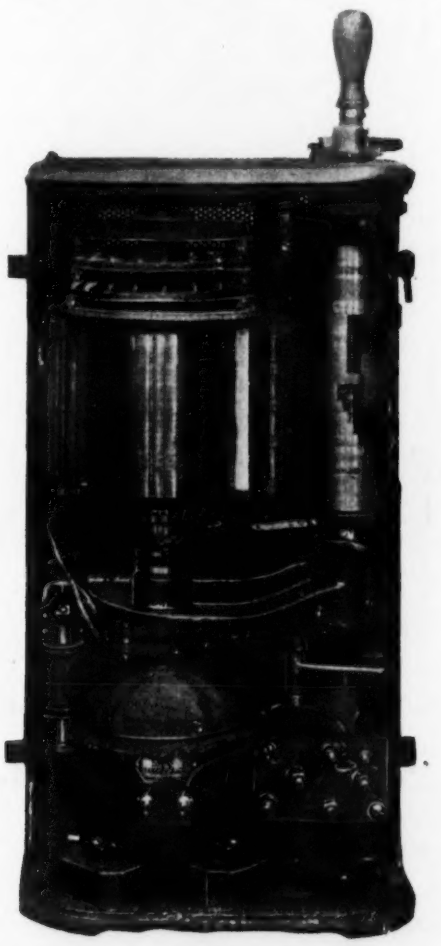


FIG. 1.—MOTOR SPEED CONTROLLER.

of which are superior to any rheostatic control system—the American Electric & Controller Company, 12 Dey Street, New York, has developed a controller which in itself accomplishes what in other systems requires not only a controlling apparatus, but also a generator source of multivoltage.

The principle of the system consists, briefly, in the intermittent connection of the working circuit with the supply circuit. That is, in a cycle of operation, the supply circuit is connected only a part of the time, the result being that the effective voltage at the motor, as measured by a voltmeter, is less than the supply voltage. The time of connection with the supply circuit can be varied, thus enabling the motor to be supplied from constant-potential mains with a voltage varying in value to accord to the speed desired.

The latest type of the controller is shown in Fig. 1. The essential part of the apparatus is the vertical commutator, which in shape and construction closely resembles the commutator of an ordinary dynamo. This commutator or "interrupter" is rotated at a constant speed of 1,500 r.p.m. by a small motor shown mounted in the lower part of the case. The terminals of the interrupter are at two

groups of carbon brushes, fed in reaction brush holders and which are in contact with the interruptor along diametrically opposite lines. By means of mechanism operated from the controller cylinder, a given number of these bars may be put in or out of circuit, thereby varying the length of time during which the supply circuit is connected with the motor circuit. The working limit of voltage variation by this means lies between the full voltage of the line and half the voltage of the line, which latter voltage is given when the least number of bars are in circuit, and therefore when the time of interruption is longest. A further range of speed, however, is obtained by the addition to the system of field control, which will be referred to later.

By reference to Fig. 1 it will be seen that the apparatus resembles in appearance ordinary forms of controllers. The apparatus in its present form is notable for the skillful and practical manner in which both the mechanical and electrical features have been

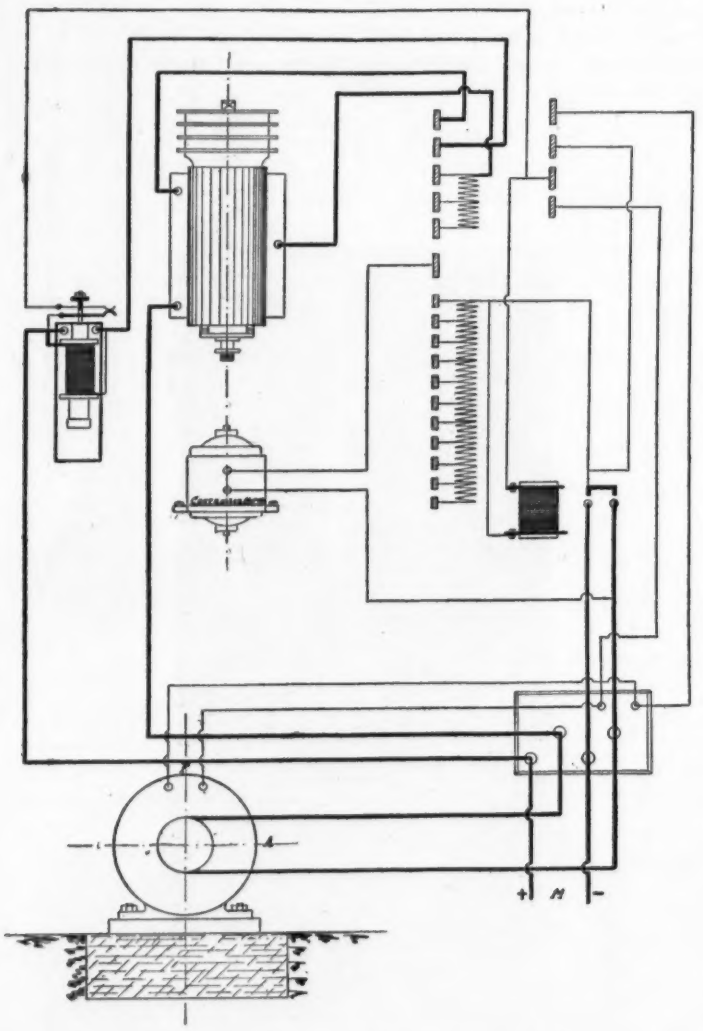


FIG. 2.—DIAGRAM OF CONTROLLER CIRCUITS.

worked out. There are no delicate parts and the controller should be able to stand even excessive abuse. Nothing has been left to the judgment of the operator. His only function is to turn the handle, provision having been made in the controller for the proper order of opening and closing the circuits, so that no damage can occur through neglect of external switches by the operator in starting up.

The various circuits of the controller are shown in Fig. 2. The detached group of contacts to the right are for the working motor field. Of the two groups of contacts in line, the upper is for the interrupter control and the lower for the field control. The coil to the right represents a circuit-breaker acting directly as an undervoltage breaker, and also through the relay shown at the left, as an overload breaker.

In turning the controller handle from the starting point the following is the order of operations: First, the interruptor motor is cut into circuit; next the working motor is connected with the supply circuit with its field winding directly across the circuit and the armature in series with the interruptor, of which the smallest number of segments is now active and the impressed voltage consequently a minimum, thus starting the working motor at the lowest speed. A further motion of the controller handle increases the number of interruptor segments in circuit, thereby increasing the impressed voltage and increasing the speed of the working motor, until finally all segments are in circuit except a few which always remain dead in order to interrupt the circuit during each revolution. The next movement of the handle short-circuits the interruptor, when the working motor runs as a plain shunt motor at full line voltage. Though the interruptor is thus thrown out of action, it is left in circuit running dead in order to allow the brushes to polish it, until the second section of motor field resistance is introduced, when the commutator motor is finally cut out of circuit. Further movement of the controller handle introduces more resistance in the field circuit of the working motor, thereby increasing its speed. Resistance is then gradually introduced until the highest speed of the motor is obtained.

The design of the controller cylinder and interruptor is such that the changes in speed are made very gradually and not by steps, causing abrupt changes. To provide for sparking at the brushes, which otherwise would take place upon the interruptions of the line connection, inductance coils are connected with the segments. In Fig. 1 these will be observed in the form of discs above the commutator or interruptor. By this means sparking is reduced to a negligible quantity. The controller is supplied with a reversing cylinder similar to that used on street railway controllers and similarly interlocked with the main controller. The handle consequently cannot be turned from the off position when the reversing switch is not in proper condition for either forward or backward running, and the reverse switch cannot be thrown while the controller handle is at any other point than the standstill position.

Commercial Cable Plans.

The stockholders of the Commercial Cable Company have voted to amend the company's charter so that it now has power to dispose of and purchase the stocks and bonds of any foreign or domestic corporation and also to lease or sell its property and franchises to any telegraph corporation. This change in the company's powers, already noted in these columns when proposed, excited much interest in Wall Street, where it was thought that the step might have something to do with the long-discussed merger of the Commercial Cable and Postal Telegraph Companies and the American Telephone & Telegraph Company, although Commercial Cable interests and the telephone interests have at all times officially denied the intention of such a step. Last March Mr. Clarence H. Mackay, of the Commercial Cable Company, organized the Mackay Companies, which invited the deposit of Commercial Cable Company stocks in exchange for the stocks of the Mackay Companies, the Commercial Cable having $15,000,000 of stock and the Mackay Companies $30,000,000 of 4 per cent. preferred stock and the same amount of common stock. The plan was accepted by the stockholders of the Commercial Cable Company, and it was thought at the time that owing to the selection by Mr. Mackay of John I. Waterbury and T. Jefferson Coolidge as co-trustees with him of the Mackay Companies the plan contemplated the ultimate taking over of the American Telephone & Telegraph Company, since both Mr. Waterbury and Mr. Coolidge are prominent directors and stockholders of the latter company. Mr. Mackay also became a director of the Manhattan Trust Company, of which Mr. Waterbury is president. Under its extended powers the Commercial Cable Company would be in a position to purchase and hold the shares of the American Telephone & Telegraph Company.

Mexican Power Concession.

The Villanueva Company, Mexico City, has secured a concession from the Government permitting the utilization of 2,000 liters of water per second from the San Geronimo River, located in the North Canton of the State of Jalisco. The company will erect a plant for generating power for manufacturing and lighting in that district.

Single-Phase Railway at Indianapolis.

President Henry, of the Indianapolis & Cincinnati Traction Company, is authority for the statement that a portion of that line, which is to be operated on the single-phase system, will be opened for traffic December 15, between Indianapolis and Rushville. The road is built for high speed, largely on private right of way. The contract for equipping the line is in the hands of the Westinghouse Electric & Manufacturing Company. The trolley voltage will be 3,300 volts. This will be reduced by a transformer on each car. As the cars must operate over the 500-volt, direct-current city lines in Indianapolis in order to gain entrance to the city, rheostatic control will be used instead of the induction control.

Aaron Electric Motor.

The illustration shown herewith is that of a motor manufactured by the Aaron Electric Company, of 141 South Clinton Street, Chicago. This machine is made in various sizes, ranging from ½ to 25 hp. It is provided with ring oilers and an adjustable base to take up slack in the belt. The Aaron Electric Company also manufactures an elevator motor, which has found much favor in the services for which it is designed. The brushes are well adapted to this work where reversal of the motor is frequent. This style of machine

ELECTRIC MOTOR.

may be set in any position or angle, making its use possible in many cases where a specially designed motor would otherwise be required.

Another line of electrical goods which is meeting with much success is the motor-generator set put on the market by this company. This is largely used in automobile charging stations. An electroplating dynamo, which is built by this firm in various sizes up to a capacity of 500 amp., has proven itself capable of withstanding the severe usage to which machines of this type are often subjected.

Tests of Allen-Bradley Controllers.

The Bethlehem Steel Company has installed at its exhibit in the Mining Building, at the World's Fair, St. Louis, a 110-volt, 7-hp Allen-Bradley electric controller for use in connection with the naval gun, which forms the principal part of the Bethlehem Steel Company's exhibit. The controller was selected by the engineer in charge, Mr. James Watters, as embodying a number of new features, making it specially well adapted for use in connection with big guns. A number of United States and foreign naval army officers have inspected the controller in connection with the exhibit. The Bethlehem Steel Company proposes to remove the present exhibit at the conclusion of the World's Fair, and to make a permanent, practical exhibit, including the Allen-Bradley controller, at its works at South Bethlehem, Pa.

The American Electric Fuse Company, of Chicago, which manufactures the Allen-Bradley controller, states that it has made a number of tests with the Allen-Bradley machine, which demonstrate the fact that there is practically no limit to the control which it affords in connection with the handling of big guns, either in land fortifications or on board battleships. The American Electric Fuse Company also states that the United States Government experts, who are investigating the merits of the controller, have found it extremely satisfactory in results upon all tests made.

Shultz Belting Exhibit.

An attractive booth and exhibit have been made by the Shultz Belting Company in Machinery Hall at the St. Louis fair. Here the hides, link belts and rawhide belts of all sizes are displayed. The leather for belting is tanned on the surfaces only and the interior of the hide, which is the fibre, is rawhide, which is softened and made pliable by a patent process. This gives it all the advantages of tanned leather, and it retains the strength of the rawhide. The grain is soft, which causes it to adhere to the pulley, and this combined with its great strength and pliability, gives it great driving power. On account of its softness and pliability it is adapted in places where belts have to run over small pulleys at high speed or where they have

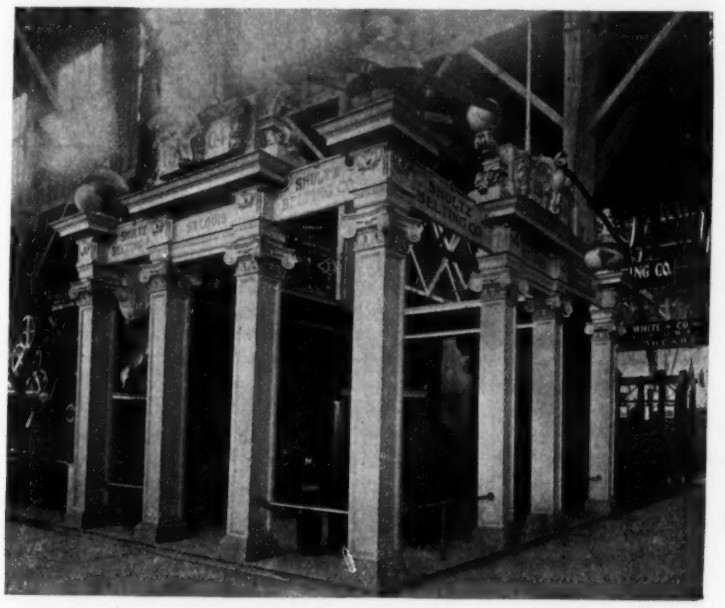
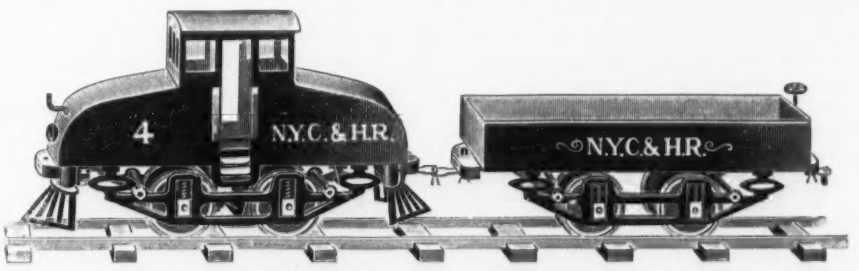


EXHIBIT OF SHULTZ BELTING COMPANY.

to run on a twist. For main drive belts on engines it has given excellent service. All this belting is put together, of selected stock that is stretched twice before made into belts. Shultz's rawhide lace leather, belt cement and belt dressing form the other exhibit items.

Miniature Electric Locomotive.

The holiday season is always a favorable time for the sale of electrical novelties. Among the new things, rather in the toy line, is a miniature electric locomotive manufactured by the Knapp Electric & Novelty Company, 511 West Fifty-first Street, New York, and illustrated herewith. The locomotive is provided with a lever, the operation of which starts, stops and reverses the direction of the engine. The power is supplied by dry battery cells, the current required being 1¾ amp. at 4 volts. The outfit consists of one locomotive, one coal car, two lengths of track 9 ft. each, 2-in. gauge,



MINIATURE ELECTRIC LOCOMOTIVE.

with cross ties and connectors. The locomotive is 10 in. long by 5¼ in. high. Its resemblance to the actual locomotives to be used on the New York Central Railroad is very striking.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market was variable, but after a sharp reaction, renewed strength developed in prices under the lead of United States Steel issues. New high-price records were made in the bonds and both classes of this stock. The strength of Steel stocks had more or less influence on the behavior of other industrial securities. It is especially noteworthy that all of the electrical stocks touched the highest prices of the year, and, with a single exception, all closed with substantial gains. The exception was Allis-Chalmers common, which closed at 20, a net loss of 2¾ points. On the other hand, the preferred made a net gain of 3 points, closing at 71, which is the highest price of the year. General Electric was unusually active and strong, 22,050 shares having been sold, at prices ranging between 194½ (the highest for the year) and 185, the closing quotation—192⅞—being a net gain of 7⅞ points. The two Westinghouse issues made net gains of 4 points each on the week's business, which was active in the common stock. The closing price of the common was 181 and of the preferred 198. The traction list was rather neglected, and weakness prevailed. Brooklyn Rapid Transit closed at 68 and Metropolitan Street Railway at 122⅜, the latter being a net loss of 2 points. The telegraph group is little changed and was quiet. Western Union closed at 92½, which is a net gain of ½, and American Telephone & Telegraph is unchanged at 145½. American District Telegraph reached the highest quotation of the year—31¼—which was also the closing price and representing a net gain of 3 points. There was activity in the curb market, both in stocks and bonds, copper shares and Interborough Rapid Transit being the most active. The latter closed at 168⅜, which is a net gain of 13¾ points. Manhattan Elevated closed, on the Exchange, at 167¾. Following are the closing quotations of November 29:

NEW YORK

	Nov. 22	Nov. 29		Nov. 22	Nov. 29
Allis-Chalmers Co.	18⅜	19	Electric Vehicle	16	16
Allis-Chalmers Co. pfd.	69	68½	Electric Vehicle pfd.	24	24
American Tel. & Cable.	89	90	General Electric.	189½	190
American Tel. & Tel.	144	148	Hudson River Tel.	..	..
American Dist. Tel.	30	..	Interborough Rap. Tran.	158	165⅛
Brooklyn Rapid Transit.	68	68⅛	Metropolitan St. Ry.	123⅜	124
Commercial Cable.	210	..	N. Y. & N. J Tel.	160	161
Electric Boat	42	40	Marconi Tel.	..	..
Electric Boat pfd.	68	67	Western Union Tel.	91⅛	..
Electric Lead Reduction.	⅛	⅛	Westinghouse com	180	..
			Westinghouse pfd	193	..

BOSTON

	Nov. 22	Nov. 29		Nov. 22	Nov. 29
American Tel. & Tel.	145	148⅛	Western Tel. & Tel. pfd.	*100	99½
Cumberland Telephone.	117	118½	Mexican Telephone.	2	2⅛
Edison Elec. Illum.	245	251	New England Telephone.	*134	139½
General Electric.	189½	189½	Mass. Elec. Ry.	16	15⅝
Western Tel. & Tel.	21	21⅝	Mass. Elec Ry. pfd.	61	62

PHILADELPHIA.

	Nov. 22	Nov. 29		Nov. 22	Nov. 29
American Railways.	49¼	49½	Phila. Traction.	97¾	98
Elec. Storage Battery.	81⅛	81	Phila. Electric.	8⅛	8⅛
Elec. Storage Battery pfd.	81⅛	81	Phila. Rapid Trans.	17⅛	17¾
Elec. Co. of America.	10¼	10⅛			

CHICAGO

	Nov. 22	Nov. 29		Nov. 22	Nov. 29
Central Union Tel.	..	..	National Carbon pfd.	109	109½
Chicago Edison.	170	..	Metropolitan Elev. com.	24	24¼
Chicago City Ry.	189	..	Union Traction.	13	12
Chicago Tel. Co.	145	..	Union Traction pfd.	43¾	46
National Carbon.	42½	45¼			

* Asked.

LONDON SUBWAY NOTES.—The listing on the New York Stock Exchange of the 5 per cent. profit-sharing secured notes of the Underground Electric Railways Company of London last week was an event of international importance, says the *New York Times*, and it has resulted in the rather anomalous condition that securities of the foremost underground railroad of Europe are listed on the New York Stock Exchange while the stock of the home underground railroad is still quoted on the curb. The listing of the London Underground Company's notes involved several features which have not been generally known. It is not the custom of the Stock Exchange to list securities of a construction company, and the London Underground is partly a construction company and will be so until January, when some of its lines will be opened and operated by it. But it is also an operating company in that it owns the control of the Metropolitan District Railway Company, which has been in operation as an underground steam railroad for forty years, and it also controls the United Tramways Company, a large system of overhead surface trolley lines in London and the suburbs. In January next one line of the system of the Underground Company proper will be opened and then the construction feature of the company will gradually disappear. Consideration of these facts convinced the authorities of the Exchange that the listing of the notes would not establish a precedent for applications to list securities of companies which are only construction companies.

PHILADELPHIA LIGHTING.—It is authoritatively reported from Philadelphia that the Philadelphia Electric-Keystone Telephone deal rumored or announced recently has not been carried through, and that a serious struggle is now on. The agreement was that the Philadelphia Electric Co. should pay $2,500,000 cash for the Keystone franchises and conduits, leasing conduit space to the Keystone for $113,000 a year; but Mr. John M. Mack has refused to carry out these terms. He state that the Commonwealth Electric Company, the new company to compete with the Philadelphia Electric, has purchased the Keystone Telephone conduits for $3,000,000, an advance of $50,000 over the price offered by the Philadelphia Electric, and the Telephone Company will pay a minimum rental of $100,000 per annum. An ordinance is expected in councils on Thursday to permit the use of the Keystone conduits for electric light wires. Mayor Weaver is said to favor and Israel Durham to oppose the ordinance, and a fight in councils is anticipated.

NEW HAVEN ROAD.—The publicity bureau of the New York, New Haven & Hartford Railroad has issued a statement summarizing improvements in progress and about to be begun between New York and New Haven. Nearly $20,000,000 is said to be involved in the work, which includes the electrification of the Harlem River Branch to New Rochelle, the purchase of twenty steam Baldwin locomotives of a new type, the installation of three bridges at Cos Cob, Westport, and across the Housatonic east of Bridgeport, the elevation of tracks at Bridgeport, and the plans for station changes at New Rochelle. The company says it is hastening these improvements for three reasons: First, several additional passenger trains have been promised to the public on December 4; second, to relieve freight congestion which has been developing fast on the New York division of the road within the last six weeks, and, third, to put an end to the delay of expresses due to the use of temporary bridges.

BALTIMORE CONSOLIDATION.—A circular was issued last week in Baltimore to the stockholders of the Consolidated Gas Company offering them $83 a share for their stock in this company. This follows an agreement made to purchase the pooled stock of the company and options procured upon individual holdings. An option given by a holder of a large block of the preferred stock of the United Electric Light & Power Company to sell all its holdings at $42 a share, is associated with the proposition to buy out the gas company. This option is good for one week. As already noted in these columns, Messrs. A. N. Brady and T. F. Ryan, of New York, are largely interested in these properties.

MONTREAL STREET RAILWAYS.—The forty-fourth annual meeting of the Montreal Street Railway Company was held last week. The president, in moving the adoption of the annual report, said the year had only been a fair one, owing to heavy operating expenses last winter. The company was placing itself in a position to handle a largely increased business and had already relaid 40 per cent. of its roadbed with 96-pound rails. The net earnings were $952,826.80, as compared with $905,939.01 in 1903. The net income per centage of capital was 11.10, as compared with 11.41 last year.

STATE FRANCHISE VALUES.—According to the State Board of Tax Commissioners, the special franchise valuation for the present year in New York State is $302,689,757, of which sum Greater New York is assessed for $251,521,450. The increase for the entire State is $17,891,165, of which increase $16,337,125 is assessed against Greater New York. Westchester County's share is this year placed at $4,817,355, and Erie County's at $13,533,940.

NORTHERN OHIO TRACTION.—The Everett-Moore syndicate has sold to J. R. Nutt, of the Citizens' Savings & Trust Company, $578,000 of Northern Ohio Traction & Light 4s, this being the entire syndicate holding in these bonds. The transaction aids the syndicate greatly, and it is now confidently expected that their affairs will be out of the hands of the bankers' committee in a few months, leaving it in good shape for the future.

THE CUMBERLAND TELEPHONE COMPANY of the Bell system shows October gross of $347,493, a gain of $45,290 over 1903, and for the four months a net surplus of $439,896, a gain of $40,130 over last year.

ELECTRIC STORAGE BATTERY.—The stock of the Electric Storage Battery Company has risen above 80, and advices from Philadelphia show the concern to be in excellent shape. The company's business for the current year ending December 31, 1904, it is estimated, will equal that of 1903, when $689,156 was surplus over the $812,435 required to pay the dividend. The growth of the company's business is indicated by the following:

Year.	Net profit.	Sur. over div.	Mkt. pr.	Stk. div. %	Earn. on mkt. pr. %
1904	.....	$700,000	83	5	11
1903	$1,501,591	689,156	49	5	18.8
1902	1,113,199	300,772	80	5	8.5
1901	900,242	87,829	59	5	9.3
1900	1,317,865	474,115	88	5	9.4
1899	924,523	.....	120	..	4.7
1898	299,670	.....	50	..	3.7

1904 results, it is estimated, will about equal 1903. The 5 per cent. dividend, which has now been paid regularly for five years, is secured by larger earnings than ever before, but relatively the stock was at its cheapest when the earnings were 18.8 per cent. on the market price for the stock, 49, in November, 1903. At present the earnings are about 11 per cent. on the market price. Before the company began dividends the stock sold high in the 100s after the Whitney-Ryan interests gained control, at a time when the profits were comparatively small. When the company made as much as $1,317,865 profits in 1903 and the stock was selling at above present prices, the income was swelled to an unusual extent for the time being by profits from sales of Electric Vehicle stocks and securities, which did not constitute a part of the regular source of income.

DETROIT EDISON BONDS.—Spencer Trask & Company in a circular offering the 5 per cent. first mortgage 30-year bonds of the Detroit Edison Company, recommended the bonds as a desirable investment. At the price, the bonds net about 4.90 per cent. The income account for the year ending October 31, 1904, shows as follows:

Gross	$653,508.61
Operating expenses	422,811,76
Net	$230,696.85
*Bond interest	112,402.51
Surplus	$118,294.34

*$46,002.17 additional is chargeable against "construction account."

For the first nine months of 1904 the gross and net receipts show an increase of 20 per cent. and 24 per cent. respectively, compared with the same period of 1904, and this earning power resulted from the operation of only the five separate generating steam plants, relatively little income having been received from over $2,000,000 of construction expenditures. Basing their judgment on the complete operation of a new generating plant, the officials publish an estimate of earnings for 1905, as follows:

Gross earnings	$825,000.00
Operating expenses	425,000.00
Net earnings	$400,000.00
Interest on bonds now outstanding	200,000.00
Surplus	$200,000.00

From the figures, it appears that the interest on the bonds is secured by a surplus of about 200 per cent. of the interest and charges. The total issue is $10,000,000 and the amount outstanding is $4,000,000.

MANHATTAN ELEVATED GUARANTEE.—The Interborough Rapid Transit Company has announced that it would pay an extra dividend on January 1 on Manhattan Elevated shares, making the rate 7 per cent. a year, although under the terms of the lease this was not necessary until next year. It says: "To avoid the adoption of an expensive system of counting the passengers and the bookkeeping that a division of fares on a mileage basis would require, and to enable the Interborough Company to carry out its agreement with the Board of Rapid Transit Commissioners, the boards of directors of the Interborough and Manhattan Companies have concluded to anticipate by a year the date when the absolute guarantee of 7 per cent., irrespective of earnings upon the stock of the Manhattan, becomes effective. The Interborough has, therefore, agreed to pay, on January 1, 1905, to the stockholders of the Manhattan, a dividend of three-quarters of 1 per cent., representing the proportion of the earned additional 1 per cent. for the preceding three-quarters of the fiscal year, in addition to the regular dividend then payable of 1½ per cent., and to pay 1¾ per cent. to these stockholders each quarter day thereafter." It is evident that the action taken by the Manhattan and Interborough boards with respect to the payment of the additional 1 per cent. dividend, if earned, upon the stock of the Manhattan Company, has been based upon the conviction that the Manhattan Company would earn the additional 1 per cent. for the year 1905, and that there has been no such diversion of travel by the opening of the Subway as to place this matter in doubt.

LIGHTING AND TROLLEY DEAL.—Advices from Philadelphia financial sources say: "In view of current talk of a possible merger or consolidation of the American Railways Company and the Electric Company of America, it is interesting to note the earning position of the two corporations. The earnings of each company over a period of three years show:

American Railways:	Income from stks. and bds. Co.s own & controlled.	Applicable to divs. after exp. direct interest charges, etc.	Dividend	Surplus.
1902	$207,608	$302,731	$178,178	$124,552
1903	274,074	274,691	223,774	50,917
1904	333,671	270,462	234,180	36,282
E. C. A.:				
1902	$366,587	$352,478	$203,979	$148,499
1903	418,893	398,979	244,716	154,263
1904	.....	*410,000	245,000	165,000

*Estimated.

"The American Railways Company is showing about $270,000 and the Electric Company of America about $410,000 net income per annum applicable to dividends, or a total of $689,000 for the two companies. This combined net income is an amount equal to over 8 per cent. on $8,000,000 capitalization, which latter figure is equivalent to the amount of the aggregate capital stock of the companies as it now stands."

BALTIMORE TROLLEY DEFICIT.—It is announced from Baltimore, Md., that the directors of the United Railways & Electric Company, of Baltimore, have decided that the net earnings are not sufficient to pay interest on the income bonds or dividends on the preferred stock due on December 1. The interest due on June 1 last was also omitted. To make these payments requires $280,000 semi-annually, or $560,000 for the year. The income bonds amount to $14,000,000 and the interest is at the rate of 4 per cent. Heavy expenditures for betterments and replacement, a part of which was caused by the fire of last February, is the cause for omitting these payments. The income bonds have declined to about 50 as the result. In the past two years considerable money has been spent on the property for tracks, new cars and powerhouse extensions. The aggregate of these expenditures is about $3,000,000. Considerable more money is yet to be spent under the policy adopted by the management. The company holds a monopoly of the street railways of Baltimore, and rumors have been frequent of late that the control of the property would pass to New York capitalists who have already invested largely in the gas and electric light properties in that city. The common stock of the company has been selling around $10 a share, the par being $50. There are 300,000 shares and at current market prices the whole capital stock would call for an outlay of $3,000,000.

MASSACHUSETTS TEL. & TEL. CO.—The Massachusetts Tel. & Tel. Co., an independent telephone company, doing business in Boston, has filed its statement of financial condition as of November 15, 1904, and compares as follows:

Assets:	Nov. 15, 1904.	Nov. 4, 1903.
Cash and debts receivable	$25,676	$22,275
Construction and rights	24,116	23,739
Balance profit and loss	....	91
Total	$49,793	$46,105
Liabilities:		
Capital stock	$10,000	$10,000
Debts	39,680	36,105
Balance profit and loss	113	.....
Total	$49,793	$46,105

The Boston & New York Telephone & Telegraph Co. owns 80 of the 100 shares.

MILWAUKEE GAS LIGHT.—The proceeds of the $1,000,000 first mortgage 4 per cent. bonds of the Milwaukee Gas Light Company will be used to pay for a new gas plant which is about completed. The company is controlled by the Western Gas Company, which is in turn controlled by the American Light & Traction Company.

DIVIDEND.—The directors of the Westinghouse Electric & Manufacturing Company have declared the regular quarterly dividend of 2½ per cent. on the preferred, assenting and non-assenting stocks, payable January 10.

THE CHICAGO CARBON COMPANY, Chicago, Ill., has increased its capital stock from $5,000 to $15,000.

Commercial Intelligence.

THE WEEK IN TRADE.—The unseasonably mild weather and a holiday retarded retail and jobbing trade, but manufacturers extend operations as confidence is strengthened by the receipt of larger contracts for future delivery, and many inquiries that promise to mature in something more tangible. Postponed orders of all kinds are now being placed, while reports from every prominent industry indicate that idle mills are reopening and the number of operatives gradually increasing. The strength of manufactured products is notable. Iron and steel have been active and strong in all lines. Finished products have been held at the recent advances, which

appear to be freely paid. A further advance of wire goods is looked for in December. A strong feature in connection with the iron trade is the activity and strength of hardware in all markets. Some orders for rails from abroad are noted. Prices in England are advancing, but American sales beyond January 1 are not thought to be heavy. All the other metals are strong, and copper shows only slight advances. The closing quotations are: Lake, 15c.; electrolytic, 14⅞c.; casting stock, 14⅝c. The business failures for the week ending November 24, as reported by *Bradstreet's*, numbered 193, against 190 the week previous and 167 the corresponding week last year. The general trade situation is one of confidence in a large business being done in 1905.

THE GREGORY ELECTRIC COMPANY, of Chicago, reports among recent shipments the following: One 400-kw Westinghouse alternator to the Beaumont Ice, Light & Refrigerator Company, Beaumont, Tex.; one 60-kw General Electric alternator to the Compania Electrica De Cardenas, Cardenas, Cuba; one 60-kw General Electric alternator to Abner Driver, Osceola, Ark.; two 125-hp General Electric motors to the city of Chicago, Ill.; one 120-kw General Electric alternator to the Owosso & Corunna Electric Company, Owosso, Mich.; one 100-kw Edison generator to the New Bedford Electric Light & Power Company, New Bedford, Mass.; two 100-hp General Electric alternating motors to the American Pneumatic Service Company, Boston, Mass.; one 50-kw Wood alternator to the Dayton Light & Power Company, Dayton, Tenn.; one 150-kw Stanley alternator to the Polar Star Electric Company, Faribault, Minn.; one 120-kw Westinghouse alternator to the Marissa Electric Light & Power Company, Marissa, Ill.; besides an unusually large number of smaller machines.

WESTINGHOUSE ELECTRIC EXECUTIVE OFFICERS.—At the last meeting of the Board of Directors of the Westinghouse Electric & Manufacturing Company, held at New York, Mr. Newcomb Carlton, of Buffalo, was appointed one of the vice-presidents of the company, the appointment to take place at once. Mr. L. A. Osborne, formerly fourth vice-president of the company, was promoted to the office of third vice-president, made vacant by the resignation of Mr. Ph. Ferd. Kobbé, who has retired from his more active duties on account of ill-health. Mr. Kobbé will continue his membership on the Board of Directors. A list of the officers of the Westinghouse Electric & Manufacturing Company, as the result of these changes, is as follows: George Westinghouse, president; Frank H. Taylor, second vice-president; L. A. Osborne, third vice-president; Newcomb Carlton, fourth vice-president; Charles A. Terry, secretary; G. W. Hebard and W. M. McFarlane, acting vice-presidents; T. W. Siemon, treasurer, and James C. Bennett, auditor.

HARRISBURG GENERAL ELECTRIC OUTFITS.—Mackenzie, Quarrier & Ferguson, 114 Liberty Street, report receipt of a number of orders for Harrisburg-Fleming engines. One order calls for the shipment of two 20 hp tandem compound engines, arranged for direct connection to General Electric generators, to the Thomas Iron Company, of Hokendauqua, Pa., for power purposes. This is a repeat order. A 60 hp side crank engine, direct-connected to a 40 kw General Electric generator has been ordered for lighting in the Lackawanna Hospital, Scranton, Pa. Smith & McNell's Hotel, Washington Street, New York, is to be installed for light with a 115 hp side crank engine, direct-connected to a 75 kw General Electric dynamo. The American "La France" Fire Engine Company, Elmira, N. Y., has ordered a 150 hp side crank engine for direct connection to a 100 kw General Electric generator for light and power service.

BIDS FOR BRIDGE PLANT.—Following are the bids received by the Commissioner of Bridges, Mr. George Best, Park Row Building, New York City, for two 75-kw generators, arranged for direct connection to 120-hp automatic high-speed engines: The Thompson-Bonney Company, of Brooklyn, $4,925; the Reeves Engine Company, of 85 Liberty Street, $4,950; the Sprague Electric Company, of 527 West Thirty-fourth Street, $4,977; the A. D. Granger Company, of 95 Liberty Street, $5,331; the Buffalo Forge Company, of 39-41 Cortlandt Street, $5,335; Frank McSwegan & Sons, Dover and Franklin Squares, $5,440; Edwin Burhorn, of 71 Wall Street; Motley, Green & Company, of 68 Broad Street, $5,600, and the D'Olier Engineering Company, of 74 Cortlandt Street, $5,738.

BIG EQUIPMENT FOR QUARRIES.—One of the largest stone quarries at Bedford, Ind., is to be equipped with the largest electric plant hitherto installed of its description. The equipment will consist of two 200-kw, 500-volt generators of C & C build, direct-connected to engines built by A. L. Ide & Sons, of Springfield, Ill. There will also be a C & C 40-kw motor generating set for lighting purposes and thirteen C & C motors ranging from 10 hp to 85 hp, aggregating in all 425 hp, utilized to operate all the quarrying machinery hoists, cranes, saws, etc. The motors will be of series and compound-wound type. The quarrying operations are at present carried on by steam power and compressed air.

EQUIPMENT FOR MEXICAN MINES.—The Poder de Dios mining property, San Cristobal River, District of Bravos, Mexico, and owned by Mr. John J. Moylan, of Mexico City, who represents the interests of various American machinery manufacturers in the southern republic, is to be extensively operated by electrical power. The mines are silver and gold. A hydraulic plant will be built on the river at a point some 1,000 meters from the mines. Current will be utilized to work the hoists, drills and lighting system. A mill and cyanide plant will be operated by means of the same power in the near future.

BIDS FOR SYRACUSE COURT HOUSE.—The new court house being built at Syracuse, N. Y., of which Mr. Archimedes Russell, of Syracuse, is architect, and Mr. J. E. Woodell, of the Treasury Department, Washington, D. C., is electrical engineer, will be equipped with a separate plant, bids for the supply of which equipment have been submitted by the Straight Line Engine Company, of Syracuse, whose tender for the complete installation is $15,011, while the General Electric quotation is $15,250.

EQUIPMENT FOR NEW YORK CENTRAL.—The New York Central & Hudson River Railway Company is about to let a very interesting contract for substation equipment in connection with its White Plains section, which is to be converted from steam to electrical power. Mr. E. B. Katte, of the company, has the matter in hand. The machinery about to be purchased comprises 24 rotary converters of 1,000-kw capacity each and 24 machines of 1,500-kw capacity each.

YAGUI POWER PLANT.—The Yagui Copper Company, Broadway-Maiden Lane Building, does not expect to go ahead on its hydraulic power development work for some time; in fact, Mr. Henry Ide Wiley, the chief engineer expert of the company, stated to a representative of this journal that it might be a year before contracts are awarded. The proposed initial equipment will be about 2,000-kw capacity. The ultimate development will be at least 3,500 kw.

EQUIPMENT FOR VICTOR METALS PLANT.—The Victor Metals Company, whose New York offices are in the Columbia, and of which Mr. F. W. Ewertz is engineer, is figuring on installing a good-sized electrical equipment at East Braintree, Mass. Mr. V. Lassen is president of the company, with headquarters there. The equipment will consist of an 800 hp plant, including about 300 hp of motors.

NEW WILLIAMS PRINTING PLANT.—The Williams Printing Company, of 238 William Street, of which Mr. David Williams is president, is to build a large printing plant on Eleventh Avenue, between Thirty-sixth and Thirty-seventh Streets, in which considerable electrical equipment will be utilized. Mr. David L. Williams, of the company, will have charge of the installation.

PLANT FOR NEW EYE AND EAR HOSPITAL.—Plans are under way for a new big ear and eye hospital on Third Avenue at Sixty-fourth Street. A good-sized electrical equipment will be installed. York & Sawyer, of 156 Fifth Avenue, are to be the architects. Mr. Frank Sutton, 91-93 Wall Street, is the heating and ventilating engineer. Several motors will be used.

PLANS FOR BABBITT PLANT.—Plans and specifications are all but completed for the electrical equipment to operate the new North Bergen plant of B. T. Babbitt & Company, the soap manufacturers, of 82 Washington Street, New York City. Mr. C. W. Aiken is the company's private electrical engineer. Alternating current machinery will be used.

EQUIPMENT FOR UNITED STATES EXPRESS BUILDING.—An isolated lighting plant will in all probability be put in the new office building to be constructed by the United States Express Company, at Trinity Place and Rector Street. Clinton & Russell are the architects.

MOTORS FOR OFFICE BUILDING.—Mr. James Robert Moore, of 156 Fifth Avenue, will act as electrical engineer for the installation in the new office building at 29 West Thirty-fourth Street. A good number of motors will be ordered.

WESTINGHOUSE TURBINE FOR CALIFORNIA.—A Westinghouse turbo generator of 500-hp capacity has been ordered for shipment to the Pacific coast for installation in the California Powder Works at San Francisco.

PLANT FOR AN INSTITUTION.—The new institution building at Mount Loretto, Staten Island, of which Mr. Raymond F. Almirall, of 51 Chambers Street, is the architect, is to have a separate lighting plant.

ELECTRICAL ORE CONCENTRATING PLANT.—The Pennsylvania Steel Company is constructing an electrical ore concentrating plant at North Lebanon, Pa., which will entail an expenditure of about $300,000.

EXPORTS TO GERMANY.—The exports of electrical machinery for the first nine months of 1904 are reported to show a total of 638 double hundredweight as compared with 277 in 1903.

HUGE MACHINE TOOL ORDERS FROM JAPAN.—Not less than $5,000,000 worth of machine tools and supplies have been purchased here by Japanese agents within the past few weeks of local machinery houses. The contracts made called for no fewer than 2,000 engine lathes of medium size, which represents an expenditure of fully $1,000,000. So anxious have the Japanese representatives been to secure immediate delivery that they have paid premiums, ranging from 10 to 25 per cent. On certain tools they have practically cleaned up all the existing stock. These American labor-saving devices are to be installed in the arsenals and shipbuilding yards at Tokio, Osaka and Nagasaki. The contracts are being placed chiefly by Mitsui & Company, Takata & Company and Okura & Company. Some big purchases have also been made by Mr. F. W. Horne, of Yokohama, one of the pioneers and largest handlers of American machine tools in the Far East. Shipments are being made in 20 carloads at a time. One of the Japanese houses before referred to has contracts in its books calling for the prompt dispatch of about a million dollars' worth of various machine tools, etc., but, at the moment, the demand is so abnormal the requisitions cannot be filled. The greater bulk of it is being sent overland to Tacoma, Seattle and Vancouver, so that the quickest possible time will be made in reaching the Mikado's Empire. The principal machine tool concerns which have already secured substantial contracts are the Niles Tool Works and the Pratt & Whitney Company, of the Niles-Bement-Pond Company; the Lodge & Shipley Machine Tool Company, of Cincinnati, O.; the Cincinnati Milling Machine Company; the W. F. & John Barnes Company; the Brown & Sharpe Manufacturing Company; the Hilles & Jones Company; the Bullard Machine Tool Company, of Bridgeport, Conn.

THE CALIFORNIA GAS & ELECTRIC CORPORATION will soon close contracts for three 4,000 kw. three-phase generators, each of which will be direct connected to a gas engine constructed by the Snow Steam Pump Works. These engines will be delivered in San Francisco in six, eight and ten months, respectively. It will take nearly a year to construct the new power plant that is to be built by the California Gas & Electric Corporation in accordance with the contract recently closed with the United Railroads to furnish sufficient power for the operation of its entire street railway system for 20 years from January 1, 1906. Bids have been called for, also, for two 4,000-kw. motor-generator sets to be used as frequency changers. These will be necessary owing to the fact that the substation apparatus of the United Railroads throughout the city is designed for 25 cycles, while the California Gas & Electric Corporation generates at 60 cycles throughout its water power transmission system. The greater part of the electric power to be supplied under the contract is expected to be obtained from the Standard transmission line, with the new gas engine reserve station as a relay.

ELECTRIC TRACTION IN THE CASCADES.—The reports are renewed that both the Northern Pacific and the Great Northern are seriously considering the use of the water power in the Cascades to haul their trains over the mountains. The coal consumption is so enormous in the mountains that the railways would be glad to adopt electric traction. A steam railway expert from one of the largest electric manufacturing companies has recently spent several weeks on the coast investigating the possibilities of electric traction on the Northern Pacific in Washington. The Great Northern's motive power department has also given a great deal of attention to the problem. The Northern Pacific crosses the Cascade Range by the Stampede Pass through the Stampede tunnel; while the Great Northern, which formerly had a switchback in Stevens Pass, now uses the Cascade tunnel at the same point.

EQUIPMENT FOR MANILA LIGHTING.—The Manila Electric Railroad & Light Company, Limited, the American concern which is constructing some 40 miles of electric roads in and around Manila, Philippine Islands, (and which acquired recently the franchise of "La Electricista," the Spanish company which had the contract for lighting the city), has decided to do away with the existing lighting plant and install new equipment in the main power plant. For lighting, a 1,500 kw Westinghouse outfit will be put down. The present lighting equipment is made up of 10 Brush dynamos of 60 lights capacity each and the 350 kw General Electric belted generators. The engines are compound ones of Buckeye build. J. G. White & Company, who have the contract for the construction and equipment of the traction system, will install the new lighting service.

FIRE AT WIRELESS STATION.—The wireless telegraph station of the De Forest Wireless Telegraph Company at the Navesink Highlands, N. J., was destroyed by fire last week. The station was fully equipped with up-to-date receiving and sending apparatus, and was used principally in communicating with the De Forest stations at 42 Broadway, this city, and the one at Paterson, N. J. It was also used in reporting the races for the America Cup during the last of the international yacht races. At the office of the company it was said that the loss would be about $3,000. A new plant, it is understood, will soon be installed in the place of the one that was burned. The cause of the fire is not known.

JUNIATA RIVER POWER DEVELOPMENT.—The Juniata Water & Power Co. is completing plans for the construction of a hydro-electric power plant on the Juniata River, above Huntingdon, Pa. The plant will have a capacity of 4,000 net horse-power with an effective head of 45 feet. An auxiliary steam plant with a maximum capacity of 3,000 horse-power will be installed. Huntingdon, Tyrone and Hollidaysburg are among the towns that will be reached by the transmission line. The office of the company is at 1038 Ridge Avenue, Philadelphia.

MACON-EVANS VARNISH COMPANY.—This firm has been formed at Pittsburg, Pa., by Mr. L. S. Macon and Mr. Cadwallader Evans, Jr. The former was for nine years secretary and vice-president of the Sterling Varnish Company. Mr. Evans is a graduate of Lehigh University, and before the organization of this new concern was connected with the Oliver Iron & Steel Company, of Pittsburg. The firm will manufacture a complete line of insulating varnishes, with office and works at Esplen Borough, and expects shortly to open a branch house in Europe.

ELECTRICAL TRADE WITH MEXICO.—The bureau of statistics of the Department of Commerce and Labor has just issued some figures as to trade with Mexico showing that exports have increased from $13,000,000 in 1890 to $46,000,000 in 1904. Scientific instruments, including electrical, rose in the period from $110,864 to $553,081. No electrical machinery was separately reported for 1894, but in 1904 the amount is not less than $564,660. At present there is an active electrical development in Mexico, chiefly through the utilization of water powers.

EQUIPMENT ORDERED FOR DEVOE & REYNOLDS PLANT.—The new plant of Devoe & Reynolds' paint factory, to be built in Brooklyn, to replace the one destroyed by fire, will be equipped with engines contracted for with the A. D. Granger Co., New York City. The contract for the generator, switchboard and wiring has been awarded to Thurston Livingston, Jr., & Co., New York. Clark & MacMullen, of 20 Broad Street, New York, are the consulting engineers on the installation work.

CHICAGO EDISON STOCK.—At a recent meeting of the directors of the Chicago Edison Company it was voted to increase the capital stock 20 per cent. The new stock will be offered to the present stockholders at par. The present issue of capital stock is $9,865,880. The increase will be $1,973,176, giving a total of $11,839,056. The company has an authorized capital of $15,000,000.

INSTALLATION FOR COLLEGE BUILDINGS.—The electrical installation for the five college buildings to be constructed between One Hundred and Thirty-eighth and One Hundred and Fortieth Streets, St. Nicholas Terrace and Amsterdam Avenue, New York, has been placed in the hands of Pattison Brothers, Flatiron Building, New York. The buildings will cost over $2,500,000.

BALTIMORE CABLE CONTRACT AWARDED.—The Maryland Telephone & Telephone Company, of Baltimore, it is stated, has awarded the contract for wires and cables for its new electric light plant to the Standard Underground Cable Company of Pittsburg. It is understood that the contract involves an expenditure of about $175,000.

MOTORS FOR FIRST AVENUE GLASS FACTORY.—Some twenty motors of different sizes are about to be purchased for use in a glass factory to be built between Thirty-seventh and Thirty-eighth Streets on First Avenue, New York, by Mr. Jacques Kahn. Mr. T. A. Maximilian, 27 Bleecker Street, New York, has the matter in hand.

GRAMATAN INN INSTALLATION.—Pattison Brothers, Flatiron Building, New York, have been chosen to act as electric engineers for the installation of the electric plant to be put in the new Gramatan Inn which Mr. W. V. Lawrence is to build at Lawrence Park, Bronxville, N. Y.

EQUIPMENT FOR GLEN GARDNER HOSPITAL.—A fair-sized electrical plant will go in the Hospital for Consumptives under construction at Glen Gardner, N. J. Pattison Brothers, Flatiron Building, New York, have been appointed the electrical engineers for the installation work.

CONTRACT PENDING FOR HEBREW TECHNICAL SCHOOL.—The contract for the installation to go in the Hebrew Technical School for Girls, at Second Avenue and Fifteenth Street, New York City, is to be let very shortly. Buchman & Forg, of 11 East Fifty-ninth Street, are the architects.

EQUIPMENT FOR YONKERS IRON WORK FACTORY.—Some electrical equipment will be put in the new iron work factory, to be built at Yonkers by Mr. Thomas Morris. E. N. Quick & Son, of Yonkers, will be the architects.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

American Electrochemical Society. Secretary, S. S. Stadtler, 39 S. 10th St., Philadelphia. Next meeting, Boston, 1905.

American Electro-Therapeutic Association. Secretary, Dr. C. E. Skinner, New Haven, Conn.

American Institute of Electrical Engineers. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

American Railway, Mechanical & Electrical Association. Secretary, Walter Mower, 12 Woodward Avenue, Detroit, Mich.

American Society of Municipal Improvements. Secretary, G. W. Tillson, Brooklyn, N. Y.

American Street Railway Association. Secretary, T. C. Pennington, 2020 State Street, Chicago.

Association of Edison Illuminating Companies. Secretary, W. S. Barstow, New York City and Portland, Ore.

Association of Railway Telegraph Superintendents. Secretary, P. W Drew, Milwaukee, Wis. Next meeting, Chattanooga, Tenn., third Wednesday in May, 1905.

Canadian Electrical Association. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Montreal, 1905.

Colorado Electric Light, Power & Railway Association. Secretary, George B. Tripp, Colorado Springs, Col.

Connecticut State Street Railway Association. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

Engine Builders' Association of the United States. Secretary, J. I. Lyle, 39 Cortlandt St., New York. Next meeting, New York City, December 2 and 3, 1904.

Electrical Association of North Dakota. Secretary, S. J. Fuller, Larimore, N. D.

Electrical Contractors' Association of New York State. Secretary, F. Fish, Rochester, N. Y.

Electrical Trades Society (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

Illinois State Electric Association. Secretary, H. E. Chubbuck, LaSalle, Ill.

Indiana Public Utilities Association. Secretary, A. M. Barron, South Bend, Ind.

Independent Telephone Association of the United States of America. Secretary, Frank G. Jones, 48 West Jackson Boulevard, Chicago.

Independent Telephone Association of Southern Indiana. Secretary, E. W. Landgrebe, Huntingburg, Ind.

International Association of Municipal Electricians. Secretary, Frank P. Foster, Corning, N. Y.

Interstate Independent Telephone Association. Secretary, E. M. Coleman, Louisville, Ky. Next meeting, Chicago, Dec. 13, 14 and 15, 1904.

Iowa Electrical Association. Secretary, W. S. Porter, Eldora, Ia. Next meeting, Dubuque, Ia., April, 1905.

Iowa Telephone Association. Secretary, C. C. Deering, Des Moines, Ia. Next meeting, second Tuesday in March, 1905.

Kentucky Independent Telephone Association. Secretary, James Maret, Mount Vernon, Ky.

Maine Street Railway Association. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

Massachusetts Street Railway Association. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

Michigan Electric Association. Secretary, J. E. Davidson, Port Huron, Mich.

National Arm, Pin & Bracket Association. Secretary, J. B. Magers, Madison, Ind.

National Electrical Contractors' Association of the United States. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y.

National Electric Light Association. Secretary, Dudley Farrand, Newark, N. J.

New England Street Railway Club. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

New York Electrical Society. Secretary, G. H. Guy, 114 Liberty Street, New York.

Northwestern Electrical Association. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis.

New York State Independent Telephone Association. Secretary, T. S. Lane, 536 Ellicott Square, Buffalo, N. Y.

Ohio Street Railway Association. Secretary, Chas. Currie, Akron, Ohio.

Ohio Electric Light Association. Secretary, D. L. Gaskill, Greenville, Ohio.

Ohio Society of Mechanical, Electrical and Steam Engineers. Secretary, C. J. Miller, Canton, Ohio.

Old Time Telegraphers and Historical Association. Secretary, John Brant, 195 Broadway, New York. Next meeting, New York, N. Y., 1905.

Pacific Coast Electric Transmission Association. Secretary, G. P. Low, 600 Rialto Building, San Francisco, Cal.

Pennsylvania State Independent Telephone Association. Secretary, H. E. Bradley, 135 South Second Street, Philadelphia, Pa.

Southwestern Electrical and Gas Association. Secretary, F. E. Scovill, Austin, Tex.

Street Railway Accountants' Association of America. Secretary, W. B. Brockway, 40 Morris Street, Yonkers, N. Y.

Street Railway Association of the State of New York. Secretary, W. W. Cole, Elmira, N. Y.

Vermont Electrical Association. Secretary, C. C. Wells, Middlebury, Vt.

Western Society of Engineers, Electrical Section. Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

General News.

THE TELEPHONE.

FAIRHOPE, ALA.—The Baldwin County Telephone Company has been incorporated with $6000 capital.

WASHINGTON, GA.—F. E. Ladd, of Atlanta, has about completed arrangements for the Washington Telephone Company, whereby every part of Wilkes County will be connected by telephone with Washington.

SPRINGFIELD, ILL.—The Alton's telegraph department has installed the long distance telephone between Bloomington and Springfield.

AUBURN, ILL.—The Auburn Telephone Company has been incorporated by W. H. Ramsey, E. R. Conklin and F. W. Kelley, with a capital of $35,000.

ALTON, ILL.—The Kinloch Telephone Company has started the construction of a telephone line from Alton to Jerseyville to connect with the Springfield line.

JERSEYVILLE, ILL.—The City of Jerseyville has granted the Kinloch Long-Distance Telephone Company permission to run a line through the city. Eight toll stations will be established and a thorough system installed in the city. North of Jerseyville, the Kinloch Company will connect with the Illinois Telephone Company.

COLUMBUS, IND.—The New Long-Distance Telephone Company is constructing a line between this city and Hope.

GREENWOOD, IND.—The Greenwood Telephone Company has increased its capital stock from $10,000 to $15,000. E. A. Robinson is president.

MONROE CITY, IND.—The Wabash Telephone Company has installed a new switchboard in the exchange at this place. This was necessary to accommodate the rapidly increasing business.

BUNKER HILL, IND.—The Central Union Telephone Company has bought the independent telephone system at this place and is now connecting the local customers with its own line. J. H. Wiles was the owner of the Bunker Hill plant and is being criticised by independent telephone men for selling to the Bell people.

FLORA, IND.—The Flora Telephone Company has incorporated with a capital stock of $25,000. This company is the out-growth of a merger of companies in which a large number of citizens of Carroll, Clinton, Cass, White and Tippecanoe counties are interested. Improvements and extensions will be made. Dr. F. P. Lyons is president.

MUNCIE, IND.—The Nostrom Lockout Telephone Company, of this city, has filed articles of incorporation with the Secretary of State. The capital stock is $600,000. The company will establish a factory here to manufacture telephones, particularly the lockout telephone, a recent patent. The directors are John Martin, George W. Beers, A. L. Johnson, J. H. Smith and George A. Ball. The latter will be general manager.

STUART, IA.—The Mutual Telephone Company is considering the building of a new exchange.

MOORLAND, IA.—The farmers in this vicinity are figuring on putting in a rural telephone system west of town.

NORWALK, IA.—The Middle Branch Telephone Company has been formed. Capital $1200. W. A. Cotinam and others are incorporators.

FOREST CITY, IA.—A new telephone line has been built between Rake and Frost. It is called the Erdahl line. M. R. Erdahl is president and O. J. Nelson, secretary.

COUNCIL BLUFFS, IA.—Articles of incorporation for the Council Bluffs Independent Telephone Company have been filed. Capital $100,000. Incorporators: F. W. Miller, T. J. Shugart, Dell G. Morgan and others. E. H. Lougee is president.

ESTHERVILLE, IA.—The Emmet County Telephone Company, of Estherville, Ia., has filed articles of incorporation with the Secretary of State. The company has a capital of $50,000. I. O. Isham is president; M. B. Miller, vice-president; A. J. Sanders, secretary, and J. B. Binford, treasurer.

HILL CITY, KAN.—The Mutual Telephone Company has been formed with $11,000 capital.

SHERMAN, ME.—The Katahdin Farmers' Telephone Company has been formed. Capital $10,000; nothing paid in. President, C. E. Milliken, Island Falls; treasurer, S. W. Porter, Crystal. Directors: C. E. Milliken, Island Falls; S. W. Porter, Crystal; C. A. Wren, G. M. Morrison and T. B. Bradford, of Sherman.

GARDINER, ME.—The Woodland Telephone Company has secured a charter to do business in West Gardiner, Manchester, Litchfield, Farmingdale, Gardiner, Hallowell and Augusta. The officers of the company are: President, Frank S. Collins, West Gardiner; treasurer, James T. Collins, Manchester; clerk, H. E. Henry, Manchester.

PORTLAND, ME.—The Wilson Long Distance Telephone Company has been organized at Portland for the purpose of conducting a general business in telephonic, telegraphic and electrical supplies and apparatus, with $250,000 capital stock, of which nothing is paid in. The officers are: President, Millard W. Baldwin, of Portland; treasurer, Geo. C. Knights, of Portland.

MENOMINEE, MICH.—The Michigan Telephone Company has started the construction of an extension of its system from Menominee to Cedar River. The line will be 32 miles in length and is expected to go into commission in January.

MARSHALL, MICH.—At a recent meeting of the Marshall Telephone Company amended articles of association were approved and the name changed to the Citizens' Telephone Company, which recently acquired a controlling interest in the local exchange. F. A. Stewart resigned as president and director of the old company and was succeeded by President Fisher of the Battle Creek exchange. It was also voted to increase the capital stock from $15,000 to $52,000,

most of which will be assumed by the Citizens' Company of Grand Rapids, the remainder being placed on the open market.

MARQUETTE, MICH.—A convention of the Upper Peninsula district managers of the Michigan State Telephone Company has been held here. It was the first meeting of the kind, but hereafter the managers will assemble in conference every six months. All sections of the peninsula were represented and in addition, President Jackson, General Manager Ladd and Attorney Thompson, all of Detroit, were present. The local business everywhere was reported satisfactory and the long distance service such as to be seriously taxing facilities. Among other improvements contemplated is early construction of an additional toll line from Detroit to the Straits and subsequently to Marquette.

WOODLAKE, MINN.—The citizens of this place are making arrangements to organize a rural telephone company.

LAMBERTON, MINN.—The Minnesota Central Telephone Company is figuring on extending rural lines next spring.

FARIBAULT, MINN.—There will soon be two rural telephone lines running from this city, one to Prairieville and another to Cannon City. Local companies have been organized along the route of the proposed lines and will begin the work of constructing the lines at once.

LAMONTE, MO.—The Lamonte Telephone Company has been chartered Capital $5000. Incorporators: W. E. Files, W. F. Yankee, H. C. Mitchell and others.

ST. LOUIS. MO.—Messrs. Widman, Walsh & Boisseller, architects, are preparing plans for a seven-story building to be erected at the northwest corner of Tenth and Locust Streets by Adolphus Busch for the Kinloch Telephone Company. The structure will be arranged especially to meet the requirements of the telephone company, which will occupy the major portion of the building and rent the remainder. The contract will be let as soon as the plans are perfected.

OAKLAND, NEB.—The Daily & Silvercreek Telephone Company's system is to be improved and a new switchboard will be installed.

WATERTOWN, N. Y.—The Citizens' Telephone Company is increasing its business rapidly, and has recently ordered two new magneto switchboards which will largely add to its facilities.

BUFFALO, N. Y.—At a recent meeting of the Frontier Telephone Company officers were elected as follows: President, H. S. Parsons; vice-presidents, E. C. Lufkins, E. S. Wayland; treasurer, S. L. Meoma; secretary, John Jolly.

ONEONTA, N. Y.—Announcement is made of the merger of the Oneonta Independent Telephone Company with the Central New York (Bell) Company. Through this move all the telephone service in Oneonta and the towns in that section passes into the hands of the Bell Company.

PORTLAND, ORE.—The Pacific States Telephone Company, of this city, will have a competitor in the local telephone field if the efforts of the striking Operators' Union are effective. Members of this organization are actively at work securing signatures to a petition for a franchise for a competitive telephone company, and already several thousand names have been appended.

MARIETTA, OHIO.—The directors of the Marietta Telephone Company at a recent meeting elected G. P. Sharp, of Waverly, and D. G. Geverz, of Parkersburg, directors to fill existing vacancies. Action was also taken on the proposal to increase the capital stock from $50,000 to $100,000 for the purpose of enlarging the local system as well as providing for extensions of the Marietta lines to Newport, Matamoras and Sistersville. Work will be started at once.

WATERTOWN, OHIO.—A deal has been closed whereby the telephone lines composing the Hayes-Harvey line, the Hayes-Harvey and Fisher line, a one-half interest in the Beverly-Waterford exchange, the Fisher-Walcott line, the East Watertown line and the McConnellsville-Stockport, Lowell and Marietta lines will be combined into one corporation with an authorized capital of $10,000. The company will be known as the Barlow-Watertown Telephone Company, and the direct lines will all center at the Watertown exchange.

SALEM, OHIO.—The Bell Telephone Company of this city has undertaken extensive additions to its lines here. Two miles of new aerial cable will be strung in Salem, and the entire local systems will be thoroughly overhauled. In addition to all this poles will be set from this city to East Palestine, a distance of 20 miles, and on them will be strung the wires for toll service. These wires will connect at East Palestine with the toll lines already running east from that point to Beaver Falls.

HENDERSON, TENN.—A movement is on foot for the purpose of organizing an independent telephone company, the cause being, it is said, the continual increase in the Bell rates.

PARIS, TENN.—At an adjourned session of the Legislative Council a 50-year franchise was granted a new telephone company, to be operated and known as the Paris Telephone Company. This company will be required to place all wires under ground within one-half block of the public square. Capital stock, $25,000.

ALVIN, TEX.—The Southwestern Telegraph & Telephone Company has purchased the Alvin & Angleton Telephone Company, including the local exchange at this place. It will make improvements at once.

BEDFORD CITY, VA.—The Bedford Southside Telegraph & Telephone Company has been incorporated. Capital $10,000. A. J. Gillespie, president; S. H. Price, Montvale, Va., vice-president.

DANVILLE, VA.—The Southern Bell Telephone & Telegraph Company will make extensive improvements in the long distance service between this city and Lynchburg, and work has already been started toward the erection of additional wires.

OTTAWA ONT.—It is stated that the Dominion government has under consideration certain legislation looking to the federal acquisition of the trunk lines of telephones and telegraphs in Canada. At a meeting in London, Ont., a short time ago, of the Union of Canadian Municipalities, a resolution strongly favoring such a system of ownership and operation was adopted.

ELECTRIC LIGHT AND POWER.

BRINKLEY, ARK.—The Farrell Light & Heat Company has been incorporated, capital $50,000. J. J. Farrell, Patrick Farrell and others are the incorporators.

OXNARD, CAL.—The Oxnard Light & Water Sompany has purchased a site on which to erect a power house.

ORANGE, CAL.—A resolution has been adopted by Council providing for the construction of water works and an electric light plant.

SAN FRANCISCO, CAL.—The Northern California Power Company, 1504 Market St., has entered into a 10-years' contract with the Mammoth Copper Mining Company, Shasta County, to supply its smelter with electric power. The smelter will utilize about 1200-hp, of which 900 will be in constant use, the remaining 300 being kept as a reserve.

DALTON, GA.—The City Council has decided to construct an electric light and power plant.

THOMASVILLE, GA.—The citizens have voted to borrow $35,000 for the purpose of purchasing or building a municipal electric light plant.

GREENSBORO, GA.—At Greensboro the citizens have voted a bond issue for an electric light plant. The bonds will soon be placed on the market.

WAYNESBORO, GA.—A decision has been rendered in court dismissing the injunction to prevent the Mayor and City Council of Waynesboro from entering into a contract for the lighting of the streets by electricity.

IDAHO FALLS, IDA.—The Idaho Power & Transportation Company plans the construction of a dam near this city, and later the construction of an electric power plant.

BOISE, IDA.—I. B. Perrine has filed upon the waters of Trout Creek, where there is a sufficient fall for the generation of 1200 horse-power and where he proposes to establish an electrical plant.

SPRING VALLEY, ILL.—The Spring Valley Lighting & Power Company has been incorporated by John McFadden, D. Reichardt and others; capital $100,000.

CHICAGO, ILL.—The Chicago Edison Company will establish a sub-station at 77-79 Plymouth Place, which property was recently purchased by the company. The station will occupy a new three-story building to be specially erected for it.

MORRISTOWN, ILL.—The Rock River Hydro Electric Milling & Power Company has been incorporated, with a capital of $50,000, to construct a dam across Rock River at Lyndon for the purpose of securing water power. Incorporators: Geo. A. Whitcomb, Edw. A. Smith and Harvey S. Green.

HAGERSTOWN, IND.—Business men of this place have organized a company for the purpose of building and installing an electric light plant here. It is announced that the work will be commenced at an early date.

WAVERLY, IA.—The City Council has purchased the Healy electric light plant.

STURGIS, KY.—A 20-year electric light franchise has been granted to the Sturgis Electric Light Company, of Sturgis. Mark E. Easton is Mayor.

LEWISTON, ME.—After more than two years the electrical development at Deer Rips is finished and the largest electric power in New England is ready for business with 10,000 horse-power available for the cities of Lewiston and Auburn.

PORTLAND, ME.—The Commonwealth Power Company has been incorporated with a capital stock of $4,000,000. The officers of the company are: President, W. A. Foote, Jackson, Mich.; treasurer, G. W. Richie, Kalamazoo, Mich.; clerk, W. M. Bradley, Portland.

BIDDEFORD, ME.—The Sanford Mills Company has purchased from B. C. Jordan three mill privileges on Mousam River and will build a large stone dam just above the town line. From the dam an iron flume six feet in diameter will extend to still water below, giving an 80-foot head for the operation of an electric power plant.

SPRINGFIELD, MASS.—Civil engineers have been at work lately taking measurements and setting stakes for dams and canals along the unoccupied water-power of the Housatonic River between the Hinsdale mills in Hinsdale and the Renfrew mill in Dalton, with a view of developing the power in the river for generating electricity for transmission. The parties for whom the work is being done do not care to be known in it, as the carrying out of the plan will depend wholly on the results of the estimates being made of the power which may be developed and the expense attending it.

BAY CITY, MICH.—The City Council proposes to let contracts at once for a commercial plant.

SPRING LAKE, MICH.—Bids will be received Dec. 1 for constructing an electric light plant here. Chas. M. Kay is village clerk.

MUSKEGON, MICH.—The Grand Rapids-Muskegon Water Power Electric Company has been organized with a capital of $1,000,000 by John G. Emery, Jr., and David D. Erwin, both of Muskegon, Mich.

WINTHROP, MINN.—The Electrical Machinery Company, Minneapolis, Minn., has been awarded the contract for the extension of the electric light plant and waterworks. The contract price was $7530.

MANKATO, MINN.—Oscar Claussen, National German-American Bank Building, St. Paul, is preparing plans and specifications for a complete railway, light, heat and power plant for the Mankato Railway, Light & Power Company, and bids for construction will be received in December.

VICKSBURG, MISS.—It is stated that the Vicksburg Water Company proposes to add an electric supply plant of 300 horse-power.

JEFFERSON CITY, MO.—The citizens have voted to grant a 20-year franchise to a Chicago syndicate to furnish electric and gas light to the city.

ST. JOSEPH, MO.—The contract for building the new power house for the municipal electric light plant has been awarded by the Board of Public Works to Warner Bros., for $13,291. The following are the bids opened on Nov. 15 by the Board of Public Works for the machinery and equipment of the city electric light plant: General Electric Company, dynamos, lamps and switchboard, $29,712; Fort Wayne Electrical Works, dynamos, lamps and switchboard, $22,450; Adams-Bagnall Electric Company, bid on lamps only, $7800; Western Electric Company, dynamos, lamps and switchboard $18,448 and $20,183.

ARLINGTON, NEB.—The Arlington Electric Light & Power Company has been granted a franchise and the plant is being installed.

PLATTSMOUTH, NEB.—The Plattsmouth gas and electric light plant has been sold to the Nebraska Lighting Company, Chas. C. Parmele, president. The company has filed articles of incorporation, with a capital of $100,000.

COMSTOCK, NEB.—It is reported that the Middle Loop Electric Company will construct an electric power plant at Comstock.

ATLANTIC CITY, N. J.—The City Council has adopted the ordinance providing for the burial of all overhead wires on Atlantic Ave.

NEWARK, N. J.—The Public Service Corporation is issuing an admirable bulletin devoted to the promotion of its business and called "Light and Power." Its Thanksgiving number, just out, is beautiful and instructive, and must certainly help to bring new customers into the fold.

ONEIDA, N. Y.—The directors of the Madison County Gas & Electric Company have organized by electing the following officers: President, C. Wellington Koiner, Oneida, N. Y., vice-president, Isaac C. Green, Providence, R. I., treasurer, Frank D. Pavey, New York.

MOUNT OLIVE, N. C.—The Mount Olive Light & Power Company has been chartered with an authorized capital of $100,000, by M. T. Kell and others.

DAYTON, OHIO.—The Dayton Electric Light Company is having plans prepared for placing its wires in underground conduits, at a probable cost of $100,000.

LOVELAND, OHIO.—This city is agitating improvements to the light, water and sewerage plants. Wm. Scott is Mayor and H. S. Stevenson, city clerk.

CLEVELAND, OHIO.—The Cuyahoga Light & Power Company has been incorporated with a capital of $25,000, by C. L. Denton, H. L. Caldwell, Abraham Lewenthal and others.

WEST ALEXANDRIA, OHIO.—The Town Council has granted the Dayton & Western Traction Company a 30-year franchise for the erection and maintenance of an electric light system to furnish commercial light.

ANADARKO, OKLA.—The City Council has employed an engineer to prepare plans and estimates for a municipal electric light plant, which is to be operated in connection with the water works now being constructed.

JACKSONVILLE, ORE.—The Candor Power Company proposes to enlarge its plant. C. R. Ray is manager.

JUNCTION CITY, ORE.—The citizens voted on Nov 7 to grant a 10-year franchise to the Junction City Mfg. Company to erect poles and string wires and furnish light for the city. L. W. Clark is city recorder.

UPLAND, PA.—Louis R. Page is reported interested in the construction of an electric light plant.

GEORGETOWN, S. C.—The Georgetown Electric Company has been reorganized and the following officers elected: H. C. Case, of Philadelphia, president; S. C. Case, of Philadelphia, secretary and treasurer; S. S. Ingman, of Florence, S. C., vice-president and general manager; L. Mouzon, of Georgetown, local manager. Extensive improvements are contemplated.

RUTLAND, VT.—Initial steps have been taken in the Legislature to enable this city to establish, if the citizens see fit, an electric lighting plant under city ownership.

BURLINGTON, VT.—The bids for the equipping of Fort Ethan Allen with electric lights have been opened and rejected by the quartermaster-general of the army and new bids will be requested. Boston firms were the lowest bidders among those rejected.

BURLINGTON, VT.—Contracts are about to be let by the street committee of the Board of Aldermen for the pole line and wiring for the municipal electric light plant. It will take about 50 miles of wire, which, with the poles, will cost $15,000. H. M. McIntosh is city engineer.

SEATTLE, WASH.—An election will be held Dec. 6 to vote on the issue of $250,000 bonds for the extension of the municipal light plant.

MORGANTOWN, W. VA.—L. A. Yeager, city recorder, writes that it has not been fully decided yet to construct an electric light plant. The matter is under discussion. If constructed, it will cost $30,000. R. L. Morris, of Morgantown, is the engineer.

MILWAUKEE, WIS.—The Council on Nov. 14 killed the ordinance to issue $150,000 bonds for the construction of a municipal electric light plant.

OTTAWA, ONT.—The water power on the Wahnapitae River, which is being developed by Messrs. Cochrane and McBittie, will be in a position to deliver electric energy next spring. The dam has been completed and the machinery is now being installed. Arrangement has been made to supply the town of Sudbury, Ont., with electricity for light and water works, and it is probable that power will also be supplied to the Mond Nickel Company.

ST. THOMAS, ONT.—Experts have agreed upon the sum of $196,000 as the price to be paid by the city of St. Thomas, Ont., for the gas, electric light and power plant at present owned by a company. The city's original offer was $188,000, which the company refused, and the matter was referred to arbitration, but an agreement was reached without an appeal to the arbitrators. The by-law for the purchase of the plant will be submitted to the ratepayers in January.

THE ELECTRIC RAILWAY.

FRENCHTOWN, N. J.—There is a movement on foot for an electric railway between this borough and Clinton, via Everittstown, Pittstown and Sidney. Rev. J. W. McManiman, of Everittstown, has taken an active interest in the work.

BELLAIRE, OHIO.—Prominent citizens of Bellaire have organized the Bellaire, Shadyside & Glencoe Electric Railway Company, and propose to build a line south from the city to Glencoe. It is expected that the road will be built next year.

ASHTABULA, OHIO.—The Ashtabula Rapid Transit Company has made a contract with the Cleveland, Painesville & Ashtabula railway to purchase power at 1½ cents per kilowatt from the Ashtabula sub-station. The company will probably permanently close down its own small power station in Ashtabula.

TOLEDO, OHIO.—The Toledo Transit & Light Company, backed by Toledo capital, has been incorporated to operate street railway and lighting plants in Toledo. The plan of the company, so it is said, is to go before the City Council and apply for a franchise in competition with the Toledo Railways & Light Company, which is now seeking franchise renewals. The officers of the company are C. E. B. Lamson, president; E. P. Mull, vice-president; Charles Fox, secretary and treasurer.

PORTLAND, ORE.—The Portland Consolidated Railway Company is the name of the consolidated Portland Street Railway and the City & Suburban Railway. The company has organized as follows: A. L. Mills, president; C. F. Swigert, vice-president; J. C. Ainsworth, treasurer; F. I. Fuller, general manager; M. E. Swigert, secretary; A. L. Mills, J. C. Ainsworth, C. F. Swigert and F. I. Fuller, of Portland, and W. A. White, of New York, directors.

PITTSBURG, PA.—The Jeanette, West Newton & Monongahela Traction Company will build a trolley line between Webster and Greensburg.

UNIONTOWN, PA.—A charter has been secured for a trolley line from Mount Pleasant to Latrobe via Pleasant, Unity and other towns. A power plant will be built at Mount Pleasant.

WEST CHESTER, PA.—The West Chester Street Railway Company is installing portable telephones on its Lenape and Kennett extension. It is expected that this service will be extended to the Downington branch later.

YORK, PA.—A charter has been granted by the State Department at Harrisburg to the York & Maryland Line Street Railway Company, capital $24,000. The president of the company is William H. Lanius, of York. The new line is to be one of the many divisions of the York County Traction Company.

HARRISBURG, PA.—The engineering corps of the Philadelphia, Lancaster & Harrisburg Electric Railway Company is now at work between Middletown and Elizabethtown. About three-fourths of the property owners along the proposed route have already granted right of way. The chief promoter of the company is Edgar A. Tennis, of Philadelphia.

LANCASTER, PA.—The capital stock of the Lancaster & Eastern Street Railway Company has been increased to $400,000. This company will build a line from Christiana to Lancaster via Paradise and the Gap. These directors have been elected: Joseph H. Espenshode, J. D. Rauck, Jonas Ely, H. P. Brockbill, E. Herr Espenshade, B. M. Herr, Warren E. Broome and M. B. Herr.

YORK, PA.—It is probable that there will be an electric railway between York and Baltimore, a distance of 57 miles. The York County Traction Company's engineers are making a survey of a projected line from York to Shrewsburk via Glen Rock. The United Railways of Baltimore has also projected an electric line from Baltimore to Cockeysville, which it is expected will be built next year. With the line from York to Shrewsbury and the line from Baltimore to Cockeysville there would be but 20 miles to build in order to make a thorough system of electric railway between York and Baltimore.

PROVIDENCE, R. I.—It is said the Providence & Danielson Electric Railway Company intends to build a power house at North Sterling, using water power instead of coal.

HANDLEY, TEX.—The Northern Texas Traction Company has let the contract for an addition to the power house at this place.

LOGAN, UTAH.—David Eccles is figuring on a proposition to build an electric railway in this city and vicinity.

SPOKANE, WASH.—The Spokane & Columbia River Railroad Company, with a capitalization of $2,500,000, is soon to be chartered. The officers of the company are Col. J. M. Fish, of Kettle Falls, Wash., president; Dr. M. B. Grieve, vice-president; Charles H. Merriam, secretary; Charles T. Uhlman, manager; S. A. Wells, attorney.

OTTAWA, ONT.—An important move has been made by the City Council of Ottawa looking to the purchase by the city of the Ottawa Electric Street Railway, the same to be owned and operated by the municipality. If the proposed deal goes through, the matter will be submitted to the ratepayers of the city for a ratification at the civic election in January next. In the event of a purchase, it is thought that the city will be in possession of the whole system next summer.

TORONTO, ONT.—An important amalgamation of electric railway interests in the City of Toronto, Ont., has taken place, and a new company has been organized under the name of the Toronto & York Radial Railway Company. This company is independent of the Toronto Street Railway. The chief officers are William MacKenzie, president; W. M. Moore, general manager; John McCarthy, assistant superintendent. The amalgamation includes the Metropolitan Electric Railway, the Mimico Electric Railway and the Scarboro Electric Railway. Big changes in the line of improvement are contemplated. The system which is to be operated by the new company includes nearly 50 miles of railway.

NEW INDUSTRIAL COMPANIES.

THE BENNETT-BIRD COMPANY has been incorporated at Chicago to manufacture automobiles and motors.

THE EMPIRE STATE DRY BATTERY COMPANY, of New York City, has been incorporated with a capital of $50,000. The incorporators are P. K. Walcott, Seward Davis and H. G. Sanders.

THE MUTUAL ENGINEERING COMPANY, of New York City, has been incorporated with a capital stock of $5000. The directors are J. B. Smith, William Horton and Percy Learned, of New York City.

THE HAVRE ELECTRIC COMPANY, of Fort Benton, Mont., has been incorporated with a capital stock of $100,000. The names of the incorporators are H. W. Turner, Max Hobgen and J. H. Smart, of Butte.

THE MAGNETIC CONTROL COMPANY, of New York City, has been incorporated with a capital stock of $1,000,000. The directors are A. L. Broughman, G. W. Giddings and A. J. Raymond, of Brooklyn.

THE ELECTRICAL CRYSTAL BATTERY COMPANY, of Marionville, Mo., has been incorporated with a capital stock of $500,000. The incorporators are W. H. Bradford, G. W. Greener, C. D. Turner and others.

THE ALUMINUM IMPROVEMENT COMPANY, of New York, has been incorporated with a capital stock of $100,000. The directors are A. J. Murphy, C. J. Clark and Jose Boxeres de Alzugaray, New York.

THE MARSHALL ELECTRIC MANUFACTURING COMPANY, of Boston, Mass., has been incorporated with a capital stock of $150,000. The officers are: President, Norman Marshall; treasurer and clerk, Felix Schoenthal, of Boston.

THE AMERICAN INSULATED WIRE & CABLE COMPANY has been incorporated by I. H. Schoen, R. C. Lewis and Joseph O. Price. The company, the capital stock of which is $100,000, will manufacture wire, tools and machinery.

THE F. K. WILKINS COMPANY has been incorporated at Camden, N. J., with a capital stock of $50,000 for the purpose of dealing in electrical appurtenances. The subscribers are Frederick K. Wilkins, Murray C. Brenneman and Newton B. T. Roney.

THE INCA COMPANY has been incorporated in Jersey City, N. J., to deal in real estate, mortgages and operate gas and electric plants. The capital stock is $150,000, and the incorporators are Felix Emmannelli, Alexander T. Garbe and Henry A. Bingham.

THE ST. LAWRENCE TRANSMISSION COMPANY, of Ogdensburg, N. Y., has been incorporated with a capital stock of $25,000. The directors of the company are T. A. Gillespie, West Orange, N. J.; M. T. Cox, East Orange, N. J.; and W. J. Wilson, New York City.

THE ROSSMAN ELECTRIC DELINEATOR COMPANY, of Rochester, N. Y., has been incorporated for the manufacture of appliances for reproducing cartoons. The capital stock is $40,000, and the directors are G. B. Rossman, New York; F. A. Ward and F. H. Ward, Rochester.

THE UNITED STATES INTERURBAN CORPORATION, of New York, has been incorporated for the purpose of financing railways. The capital stock of the company is $100,000, and the names of the directors are C. C. Clark, and F. S. Clark, of New york, and W. S. Jones, of Brooklyn.

THE MARION MOTOR CAR COMPANY, of Indianapolis, Ind., has incorporated with a capital stock of $100,000. The company will manufacture and deal in motor cars, motor boats and motor vehicles of all kinds. L. C. Boyd. H. M. Landon, R. H. Hessler and others are the incorporators.

THE ELECTRICAL AUTO-TRANSFER COMPANY, of St. Louis, has been incorporated with a capital stock of $25,000, to conduct a general electrical equipment, construction and repair business. The incorporators are Charles R. Skinker, Merritt M. Beck, Clarence B. Beck, of St. Louis; Joel C. Slaughter, of Dallas, Tex.; Horace W. Beck, Charles N. Coen and William S. Walker, of Webster Groves, Mo.

THE UNITED ILLUMINATING COMPANY, of Portland, Me., has been organized for the purpose of dealing in shares of capital stock, bonds, mortgages, debentures, notes and other securities, etc., of corporations of the State of Maine, or of any other State or foreign country, and for other purposes, with $1,000,000 capital stock, of which $7000 is paid in. The officers are: President, Harry L. Cram, of Portland; treasurer, A. J. Desmond, of Portland.

LEGAL.

MICANITE PATENTS.—We are informed by the Micanite Company that the Supreme Court of Germany has, by its judgment of November 5, 1904, confirmed the validity of the German patent No. 73,830, the property of the Mica Insulator Company, Ltd., of the Empire Works, Walthamstow, for the manufacture of Micanite plates, and has dismissed with costs the appeal of Meirowsky & Company, of Cologne, for the withdrawal of this patent. A few weeks ago the same company amended its English Micanite patents No. 10,430 and No. 6,048.

OBITUARY.

MR. C. H. KENDALL.—A special dispatch from Schenectady of November 26 says: Cyrus H. Kendall, assistant foreman of the testing department at the General Electric Works in this city, and whose home is at Norfolk, Conn., was instantly killed this morning by coming in contact with a live wire carrying 2300 volts. He was 22 years of age and was a graduate of Yale.

EDUCATIONAL.

UNIVERSITY OF MAINE.—Lord Hall, the new laboratory for mechanical and electrical engineering, has been dedicated. This new building was completed in September and has been in use since then. An appropriation of $35,000 was granted by the State for its construction, and the laboratory is well equipped and in every way up to date. By vote of the trustees it was named Lord Hall, in honor of Hon. Henry Lord, for twelve years a member of the board of trustees, and for eleven years president of the same.

WORCESTER POLYTECHNIC INSTITUTE.—The D. & W. Fuse Company of Providence has presented to the electrical engineering department of the institute an exhibit board showing the various protective devices for electric circuits manufactured by it. The same department has also received word within the past few days from the Cooper Hewitt Company of New York that a new mercury vapor lamp, embodying the most recent improvements, would be presented to the institute in a short time. A mezzanine floor is being constructed at the Worcester Polytechnic Institute in one of the electrical enginering laboratories. This floor is necessary in order to provide space for the large additions to the equipment which have been received during the past two years. It will be devoted solely to apparatus representing arc lighting systems. In the space left vacant by the removal of the arc lighting equipment will be installed apparatus for high potential research work.

PERSONAL.

MR. RALPH D. MERSHON, consulting engineer, has changed his address from 29 Broadway to 11 Pine St., New York.

MR. H. HOBART PORTER, of Sanderson & Porter, New York City, left on a trip to California this week. He expects to return about Christmas.

MR. CARL HENTZEN, chief engineer of the municipal electrical plant at Copenhagen, Denmark, has left for home after several weeks' sojourn on this side.

PROF. HARRY E. CLIFFORD has been appointed as full professor of theoretical electricity at the Massachusetts Institute of Technology, and not to the "free professorship," as was stated in our issue of Nov. 19.

MR. C. H. HODSKINSON, a prominent member of the staff of the Boston Edison Company, and well-known in the electric lighting field, was married on October 12 to Miss Ethel Mabelle Rogers, daughter of Mr. and Mrs. C. Kingman Rogers, of Boston.

MR. J. W. ROGERS, of Barre, a graduate of Worcester Tech '01, has accepted a position in the mechanical engineering department of the Pennsylvania Railroad at Altoona. Mr. Rogers has been with the General Electric Company at Lynn since graduation.

CAPTAIN E. A. SAWTELLE, who has been for a long time with the Westinghouse interests, both in America and England, has just sailed from London, and will be married early in December at Irvington-on-the-Hudson, to Miss Julia H. Worthington, daughter of Mr. Chas. C. Worthington, son of Henry R. Worthington, whose name is so well known to all engineers.

MR. PHILIP DAWSON, of London, writes us with regard to our recent article on the trolley system at Mandalay, Burmah, that Messrs. Kincaid, Manville & Dawson, of Great George Street, Westminster, were the consulting engineers. They prepared all the detail plans and specifications, and superintended the carrying out of the work on the spot, where they were represented by a member of their staff.

MR. GEORGE H. BERG.—The New England offices of the Allis-Chalmers Company in Boston, which are now in the Board of Trade Building, and the offices of its electrical department, the Bullock Electric Manufacturing Company, in the Journal Building, will be consolidated on December 1 and removed to the State Mutual Building, 50 Congress Street. Mr. George H. Berg will the manager in charge of the consolidated offices.

MR. O. L. REMINGTON, of the Melbourne, Australia, firm of Wm. McLean & Co., has been visiting his home in this country, and has now left for England and the Continent, intending to return to New York about December 21, en route for Australia. He is open for negotiations with manufacturers desiring to reach the Antipodean market. The firm handles exclusively there the Bullock and Wagner products, Columbia incandescent lamps, and Robbins & Myers motors.

MR. F. S. PEARSON will shortly pay a visit to Rio Janeiro regarding the project of the Rio Janeiro Tramway, Light & Power Company, the $25,000,000 Canadian capitalized concern which plans to construct a huge power transmission system to operate the tramways and lighting in the Brazilian city. Mr. Pearson is consulting engineer for the company. He is now on his way back from Mexico, where he has been inspecting the progress made in the construction of the Mexican Light & Power Company's system.

MR. NEWCOMB CARLTON has been appointed fourth vice-president of the Westinghouse Electric & Mfg. Co. Mr. Carlton was Director of Works at the Pan-American Exposition, in which position he displayed great executive ability, and recently vice-president of the Bell Telephone Company, of Buffalo, which position he has resigned to go with Mr. Westinghouse. The headquarters of Mr. Carlton will be in the executive offices of the company at 120 Broadway. His duties will be of an executive nature, although he is an engineer by profession.

DR. LOUIS DUNCAN, who is known throughout the scientific world for his attainments in electrical work, is another of the prominent men who have become associated with the staff of the Allis-Chalmers Company of Milwaukee. He has been retained as an expert in electrical patent work in connection with its electrical department by the Bullock Electric Manufacturing Company of Cincinnati. Dr. Duncan will continue to make his headquarters in New York at 56 Pine St., where he will be closely in touch with the legal and executive offices of the Allis-Chalmers Company.

"CROCKER-WHEELER."—A dispatch from Boston says that two fifteen-year-old boys of that city have established a wireless telegraphic connection between their homes, half a mile apart. This recalls the fact that thirty days after the appearance of the first published accounts of Bell's invention of the telephone, two New York boys had built and were successfully operating an experimental telephone system of their own. The two ingenious and enterprising youths have since achieved distinction in the electrical field, and were for many years allied in business. They are Prof. Frank B. Crocker, of Columbia University, New York City, and Doctor Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, Ampere, N. J.

MR. DAVE HENNEN MORRIS has been elected president of the Automobile Club of America. He is widely known as a thorough sportsman, as well as a man of affairs and fortune. He is a graduate of Harvard and has qualified as a physician. He is an accomplished musician. He was one of the first members of the Automobile Club, first elected to the Board of Governors in 1900, when there were two tickets, both of which nominated him. Re-elected to the Board of Governors last year his term still had two years to run. Has been acting chairman of the Racing Committee for the last two years. He is a member of the Metropolitan, University, Racquet and other New York clubs.

MR. W. STANLEY.—A special dispatch from Great Barrington, Mass., of November 23, says: "Brookside," the home of William Stanley, a well-known electrician, situated about a mile and a half from the center of the town, was burned to-day, the owner and his family barely escaping. The fire originated among bundles of kindling wood in the basement, and rapidly extended upward. The Stanley family had not arisen, but were awakened before the smoke overcame them. They had no time to dress or to save anything, but all were able to leave the burning structure without sustaining injury. The house was a large wooden one, two stories in height, with a cupola, and was built in 1855 by David Leavitt, of New York, one of the earlier summer cottagers. The building contained much furniture and articles purchased abroad. In one room alone there were antiques valued at $5000. The total loss is estimated at $65,000. The insurance on the house amounts to $27,000 and on the contents $23,000. It will be remembered that on the occasion of the visit of the American Institute of Electrical Engineers to the Berkshire Hills, a charming fete champetre was given at Brookside by Mr. and Mrs. Stanley.

CHANGES AT LOS ANGELES, CAL.—Several changes have recently occurred in the personnel of the Edison Electric Company of Los Angeles, Cal. The resignation of Mr. O. H. Ensign to accept a position as consulting engineer with the Reclamation Service has already been mentioned in these columns. The office he filled, electrical and mechanical engineer, has been abolished, the duties being merged into the position of general superintendent. Mr. Clem A. Copeland, superintendent of distribution of the company, has resigned to engage in consulting electrical and mechanical practice in Los Angeles, his duties being divided among the new general superintendent and other officials. Mr. Benj. F. Pearson, formerly superintendent of power, has been advanced to the important position of general superintendent, and in the discharge of his duties has entire charge of new electrical construction as well as the supervision and the operation of all the Edison plants and transmission lines. Mr. C. H. McNary has resigned his position as chief of the testing department to accept a situation with Mr. Samuel Starrow in the construction of the new hydro-electric plant near Walla Walla, Wash. Mr. H. H. Sinclair, vice-president of the Edison Electric Company, has returned from an eight-months' trip on his yacht to the Sandwich Islands, the Philippines, Japan and other Eastern countries and assumed his former duties.

MR. B. J. ARNOLD is receiving the congratulations of his friends on the lucky escape of his children during a recent adventure in the mountains of Colorado. The story is told in the newspaper despatches of November 17, as follows: "Miss Maud Arnold, 17 years old, and her brother, Stanley Arnold, two years her junior, children of B. J. Arnold, spent last night on Cameron's Cone and nearly lost their lives as a result of their inexperience. Accompanied by Harold Maurer, a youth who had never been on a mountain, the brother and sister left here at 10 o'clock yesterday morning. The boys were without overcoats, while Miss Arnold wore a China silk shirtwaist, but carried a light-weight cloth jacket. They expected to return in four hours and took no lunch. They made the ascent on foot. The summit, which rises 10,000 feet above the sea level and 3,000 feet above surrounding foothills, was reached at three o'clock in the afternoon. Descent was delayed too long and very soon after the young folk started back the trail was lost and darkness settled down. Bowlders and chasms were on every hand. Fortunately the party had six matches. A fire was built under the shelter of a big rock, and the night might have been comfortably spent had not Miss Arnold got so near the fire that her celluloid combs ignited, setting fire to her hair. She had removed her hat. By vigorous use of their hands the boys extinguished the fire with the aid of snow, but the girl's scalp was badly burned. Searching parties left here at midnight, but failed to find the little party. When daylight came the children made the descent without further mishap and home was reached at ten o'clock this morning."

Trade Notes.

ARNOLD ELECTRIC POWER STATION COMPANY, Marquette Building, Chicago, has just issued an excellent map of the electric railway system of Illinois, showing an interesting and remarkable development in that State.

THE TIPLESS LAMP COMPANY, New York, reports a steadily increasing business in its miniature and candelabra lamps. The novelty of tipless miniature lamps appeals very much to the trade and they possess other features of importance.

GEORGE H. BUCKMINSTER & COMPANY have opened offices at 155 Milk Street, Boston, with the purpose of dealing in electrical specialties. The firm comprises the gentleman giving it his name and Mr. Charles F. White, both of whom have had a long experience in New England in the electrical supply trade, so that they are well acquainted with its wants and requirements.

PIPE, FITTINGS AND VALVES.—An excellent little manual on the dimensions of pipe, fittings and valves, by W. D. Browning, has just been issued by "The Draftsman," of Cleveland, Ohio. It is an octavo of 82 pages in flexible buckram cover and contains also a lot of valuable data on steam heating, bathroom fixtures, etc. The dimensions given are taken from fittings actually in use or in supply stores.

THE BARKELEW ELECTRIC MFG. COMPANY, of Middletown, Ohio, is now fitting up a larger plant than it has heretofore had. The constantly increasing demand for its line of "Premo" standard switches has necessitated increased facilities for the production of a heavier output. It expects to be in good running shape early this month, with adequate facilities for serving its customers with reasonable promptness.

WESTERN ELECTRIC COMPANY, 259 South Clinton Street, Chicago, has issued three new bulletins, Nos. 7030, 7035, 7040, relative to its new line of arc lamps, and dealing respectively with the multiple series and constant current lamps for direct circuits; multiple constant potential alternating current lamps; and multiple constant potential direct-current lamps. The bulletins are well done and give a large amount of necessary information.

McLEOD, WARD & COMPANY, 27 Thames Street, New York City, are doing a good business with their new 18-A incandescent lighting fixtures, which have been made to meet the demand for a cheaper fixture than the No. 1, and at the same time be practical and serviceable. It is made on the principle of their orchestra lamp, one half the cylinder revolving around the other half, so that the opening for light may be almost entirely closed and extended as much as desired. The telescoping arm of the desk lamp is the same as on their No. 1.

THE PHOENIX ELECTRIC COMPANY, whose incorporation has been noted recently, was formed for the purpose of taking over the refilled and refilling portion of the business that has been done in the past by the Sterling Electric Mfg. Company, of Warren, Ohio, the manufacturer of incandescent lamps. The reason stated for this is that the General Electric Company is not willing to grant a refilling license to any manufacturer of new lamps; so that in order to continue the refilling it was necessary to incorporate the separate company to receive a license and carry on such business.

THE GREGORY ELECTRIC COMPANY, South Clinton Street, Chicago, has just secured a very large number of transformers which it is offering for quick sale at very attractive prices. These transformers will be listed in its December bargain sheet, and it will pay parties interested in transformers to get in touch with them. The Gregory Electric Company has also received the final shipment on 4000 Thomson recording wattmeters. The same are listed in its December bargain sheet. Thomson recording wattmeters are generally very scarce in the second-hand market and this purchase offers an excellent opportunity to secure some of these very desirable instruments at very low prices. All of this lot of meters is of the better and later types, having the entire brass frames and bases.

COMMUTATOR TURNING DEVICE.—One of the exhibits that attracted a great deal of attention at the Exposition at St. Louis, just closed, was the commutator turning device shown in the space of the Wesco Supply Company. Instead of it being necessary to remove the whole armature from the machine, and putting the machine out of commission entirely during the time required to place the armature in a lathe and turn down the commutator the old way, the Jordan device brings a turning wheel to the commutator and turns it down by the rotation of the armature. The device is attached to the generator frame very quickly, and is just as readily removed when the operation is finished. The wheel is a special one that is made for this apparatus. It grinds down a pitted or furrowed commutator, leaving a smooth and highly polished surface. The wheel does not contain emery or any mineral substance that would injure the commutator. The Wesco Supply Company is the agent in the West for this device, which is manufactured by Jordan Bros., 74 Beekman Street, New York.

A NEW CHRISTMAS TREE OUTFIT.—The Central Electric Company, Chicago, is sending out circulars to the trade calling attention to the fact that it is prepared to supply from Chicago stock Christmas tree lighting outfits, and states that the figures it is able to quote are unusually attractive. The outfit contains 27 lamps 2-cp. of assorted colors, red, green, blue, frosted, canary and amber. There are 24 sockets and 27 lamps, the three extra being included in case of breakage. The sockets are water-proof and, being enclosed, eliminate the possibility of an electric shock; 50 feet of lamp cord, attachment plug, Edison or T.-H. base, as specified. Each socket has three stands of eight lamps each, which properly distribute the lamps. The entire outfit will cover a space 15x18 feet, enough illumination to light a room 30x30 feet, with a 12-foot ceiling. The Central Electric Company is enthusiastic over the outlook for trade in this particular line and also reports a very gratifying trade on portable lamps, electric chafing dishes, toy electric railways and other holiday specialties, for which it is headquarters.

THE AMERICAN FUSE CO., of Chicago, New York and Atlanta, manufacturer of the Allen-Bradley electric crane controller, announces that it is now prepared to accept orders for all sizes of electric controllers. The company has been busy in the past six months preparing for the market a number of new designs of controllers and at the present time, beside the present line of well-known Allen-Bradley crane controllers, orders are being filled for controllers for all purposes. The American Electric Fuse Company makes a liberal offer to all customers purchasing Allen-Bradley controllers. The proposition of the company is three months' free trial, with the privilege of returning the goods if not satisfactory, and one year's guarantee against any repairs. It is said that, although the company has sold a large number of controllers, there has not a single machine been returned as unsatisfactory. The American Electric Fuse Company, before Jan. 1, will have a complete line of rheostats of all types, which it will sell under the same guarantee as the crane controllers. The business of the company has been very prosperous and the factory equipment has been more than doubled during the past three months.

THE REEVES ENGINE COMPANY has opened an office at 1612 Monadnock Building, Chicago, Ill., which will be in charge of Mr. Joseph B. Hall.

BALL ENGINES.—The New York & Pennsylvania Company, Johnsonburg, Pa., has recently placed an order with the Ball Engine Company, Erie, Pa., for two 1000-hp vertical Corliss cross compound engines, direct connected to generator.

TAP AND REAMER WRENCH.—The J. M. Carpenter Tap & Die Company, Pawtucket, R. I., has just issued a circular in regard to its Nichols tap and reamer wrench, pointing out its advantages and good features. A price-list of the five different sizes is also given.

MARSHALL FIELD & COMPANY, of Chicago, have recently issued for distribution, a neat folder entitled "Shopping by Telephone." The folder is issued for the special benefit of people who are pressed for time, and there is some interesting reading regarding the convenience and dispatch of the telephone in business use.

DEEP WELL PUMPS.—A special steam-head for operating deep-well pumps is described in Bulletin L-602, published by the Laidlaw-Dunn-Gordon Company, of New York City. This device is designed for pumping from all classes of wells where it is necessary to place the pump cylinder far below the steam cylinder.

BALL & WOOD WORLD'S FAIR AWARD.—The Ball & Wood Company has on exhibition in the Philippine Government Board section of the Louisiana Purchase Exposition, World's Fair, a 20 in. x 27 in. stroke Corliss valve, Ball & Wood engine. To this exhibit the International Filipino Jury of the Exposition has awarded a gold medal.

THE PHOENIX IRON WORKS COMPANY, of Meadville, Pa., has received notice from St. Louis that the International Philippine Jury of the Exposition, in its capacity of Associate of the Board of the Exposition, under the presidency of the Secretary of War, Honorable William H. Taft, has awarded them a gold medal for the compound engine exhibited in the power plant of the Philippine Government Board.

AUGUST MIETZ, 128 Mott St., New York, has received a gold medal and special diploma awarded to the Mietz & Weiss oil engine at the Louisiana Purchase Exposition, at St. Louis. The awards received for this type of engine include one from the American Institute, 1897, medal of excellence; the Paris Universal Exposition, 1900, highest award for direct oil-engine generator set; Pan-American Exposition, 1901, gold medal; Charleston Exposition, 1902, gold medal.

THE WILMINGTON FIBRE SPECIALTY COMPANY, Wilmington, Del., is devoting special attention to manufacturing fibre for electrical purposes. It has invented, devised and installed some entirely new machinery for turning out fibre rods and has therefore exceptional facilities for furnishing promptly rods in all sizes. Of course, its product is also carried in sheets of various thicknesses, and it devotes special attention to manufactured shapes for various purposes.

PRODUCER GAS.—Under the title "Producer Gas, its Uses and Cost," the Wile Power Gas Company, Rochester, N. Y., has issued a pamphlet in which is given much useful information on this subject. It describes and illustrates the apparatus used in the manufacture of the gas, the fuel consumption and cost per annum of gas power compared with other powers, etc. The whole subject is well covered and the pamphlet will be of much interest to everyone using power in any form.

ENGLISH PUMPS TO THE FRONT.—The International Jury of Award of the St. Louis Exhibition has awarded a silver medal to the Pulsometer Engineering Company, Ltd., of Reading (makers of the well-known Pulsometer Steam Pump), for the "Geryk" vacuum pump, and a bronze medal to the inventor, Mr. H. S. Fleuss. Owing to the high vacuum obtainable from it, this pump is largely used for exhausting incandescent lamps, Rontgen ray tubes and other purposes where a high vacuum is essential. It is interesting to find that the excellence of these British pumps enables them to be sold in the United States, notwithstanding the import duty of 45 per cent.

A GREAT SIGN.—The excellent bulletin of the New York Edison Company in its November issue gives among other striking illustrations a full-page view of the huge incandescent sign that has been put up on the Butterick Building in this city, a vast establishment devoted to the production largely by electric power of printing matter and paper patterns relative to women's dress. The initial letter is no less than 68 feet high, covering four top floors of the building. The complete sign contains 1200 lamps. This is said to be the largest electric sign in the world and "seeable from Mars." There is no doubt it attracts the eyes of many of the daughters as well. It does not take many signs like this to build up the load of a central station.

ALTERNATING CURRENT MOTORS.—Bulletins Nos. 141 and 142 of the Stanley Electric Mfg. Company, Pittsfield, Mass., are devoted respectively to S. K. C. induction motors and to single-phase induction motors. The line of the first-mentioned class is divided into three types, namely, one having a short-circuited armature, another with an internal resistance in series with the armature, and a third with an external resistance connected in series with the armature by means of slip rings on the motor shaft. The second bulletin describes in detail a line of condenser and hand-starting motors. Both bulletins illustrate the various types very fully, showing their construction in detail.

WATER TURBINES AND CENTRIFUGAL PUMPS.—With this title the I. P. Morris Company, Philadelphia, has issued a handsome large-page pamphlet giving an account of the hydraulic department of the Port Richmond Iron Works and types of hydraulic machinery manufactured there. A valuable feature consists of illustrations in detail of the turbines furnished by this company for several of the large Niagara plants and the Trenton Falls and Shawinigan Falls plants. In the centrifugal pump section are photographic and sectional views of immense centrifugal pumps, one of which, built for the New Orleans Drainage Commission, has a capacity of 2500 gallons per second against a head of 10 feet. This pump, as is the case of all the pumps of the New Orleans drainage system, is driven by an alternating-current motor.

THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, Chicago, it is said, has devised a system which enables it to build its regular self-restoring drop magneto switchboard in such a manner that the system may be used originally as a generator-call local battery plant and changed at any time into a strictly central-energy system by simply adding the necessary central office battery or power plant. Changing from generator-call to central energy does not require discarding any part of the central office apparatus. This enables telephone companies, when rebuilding small generator-call plants, to first put in the necessary switchboard and at any time later install the power plant and make the necessary changes in the telephones and ultimately have a complete central-energy system without discarding any of the apparatus installed of this make.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has recently closed the following contracts for "Chloride" accumulator installations: Two 3-wire batteries for the Union Electric Light & Power Company, of St. Louis; one 3-wire battery and one exciter battery for the Edison Electric Illuminating Company, of Boston; one 3-wire battery for the Rochester Railway & Light Company, and an increase in the capacity of the first battery installed for the Rochester Railway Company in November, 1898; an exciter battery for the Interborough Rapid Transit Company, New York; a railway regulating battery for the Public Works Company, Bangor, Me; a lighting and power battery for the New York Hall of Records, contracted for through the Chas. L. Eidlitz Company; residential and isolated lighting batteries for Mrs. T. Harrison Garrett, Baltimore; Mr. C. W. Hazleton, Turners Falls, Mass.; Mr. E. O. Meyer, Charlottesville, Va.; Mr. Ogden Mills, Staatsburg-on-Hudson, N. Y.; Mr. C. S. Kates, Bacton, Pa.; Bank of Hamilton, Ont.; J. W. Sefton Mfg. Company, Chicago; Geo. Bullen, Oconomowoc, Wis.; Des Moines Union Railway, Des Moines, Ia.; Fidelity Trust Company, Philadelphia.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED NOVEMBER 22, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

774,758. ELECTRIC SPARK GAP; Thomas B. Kinraide, Boston, Mass. App. filed May 25, 1904. Heat-separating devices located adjacent to the discharge gap for diverting and separating from the electric current the heat effects and providing a cool discharge between the electrodes. (Issued Nov. 15.)

775,310. VARIABLE SPEED MOTOR; Mathias Pfatischer, Philadelphia, Pa. App. filed April 7, 1904. The improvements comprise auxiliary field pole pieces small as compared with the main pole pieces which are located between the latter and provided with coils connected in series with the armature, the conditions being such as to give the proper field for commutation without sparking.

775,317. ELECTRIC CONTROLLER; Harry C. Smith and George E. Lippert, Chagrin Falls, Ohio. App. filed April 2, 1904. Details of a switch for cutting the motor of a compressor into and out of circuit.

775,322. INSULATED RAIL JOINT; George A. Weber, New York, N. Y. App. filed Jan. 27, 1904. A special arrangement of insulating plates between the rails, chairs and fish-plates.

775,329. ENGINE STOP; James H. Cary, Providence, R. I. App. filed Feb. 18, 1904. The object, besides the automatic stopping and starting of the engine is the augmentation of the power and its concentration upon the valve stem.

775,334. ALTERNATING-CURRENT ELECTRIC MOTOR; Benjamin G. Lamme, Pittsburg, Pa. App. filed Feb. 27, 1904.

775,337. WIRELESS TELEPHONE; Roberto Landell De Moura, New York, N. Y. App. filed Oct. 4, 1901.

775,390. ELECTRICAL SIGNALING APPARATUS; Sewall Cabot, Brookline, Mass. App. filed March 23, 1904. An electro-chemical attachment applicable to a telegraphic repeater and having special utility as a means for automatic communication with and control over automatic electric switch-operating apparatus.

775,408. ELECTRICAL REGISTER AND SYSTEM THEREFOR; Louis A. Schmidt, Chicago, Ill. App. filed Feb. 5, 1904. A telephone register embodying various improvements.

775,416. ELECTRIC SYSTEM OF TRANSMISSION; Charles G. Burke and Edward J. Burke, Brooklyn, N. Y. App. filed Dec. 17, 1903. One of the purposes of this invention is to prevent unduly rapid consumption of battery and to protect or prevent impairment of the points of interruption of the transmitter. This is accomplished by associating two transmitting systems with the contacts, respectively, and sending the impulses representing the signals alternately over each transmitting system. This gives the battery time to recuperate and the points time to cool off.

775,439. ALTERNATING-CURRENT MOTOR; Ernst J. Berg, Schenectady, N. Y. App. filed April 9, 1904. (See Current News and Notes.)

775,442. ELECTRIC ARC LAMP; Tito Livio Carbone, Berlin, Germany. App. filed April 19, 1904. Details.

775,445. CONTROLLING SWITCH FOR ELECTRIC CIRCUITS; Maxwell W. Day, Schenectady, N. Y. App. filed May 9, 1904. The shaft of the controller carries two cylindrical commutators upon which carbon brushes bear to control the resistance.

775,453. REGULATING DYNAMO-ELECTRIC MACHINES; Wilbur L. Merrill, Schenectady, N. Y. App. filed June 11, 1902.

775,458. DYNAMO ELECTRIC MACHINERY; Henry G. Reist, Schenectady, N. Y. App. filed May 9, 1902. The magnetic circuit is shaped peculiarly so as to secure stability of operation throughout a range varying from low field strength up to saturation.

775,461. ELECTRIC CIRCUITS AND APPARATUS FOR RAILWAY SIGNALING; Henry W. Spang, New York, N. Y. App. filed Jan. 19, 1903.

A track circuit having relays located at points distant from each other normally out of circuit and respectively controlling independent short signal circuits, the idea being to prevent damage from electric storms by the induced electricity of the long circuits flowing into the controlling track circuit by way of the relay.

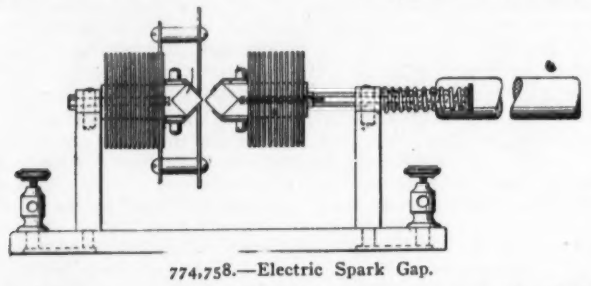
775,472. METHOD OF CONVERTING THE ENERGY OF FUEL INTO ELECTRICAL ENERGY; Hugo Jone, Chicago, Ill. App. filed Nov. 18, 1901.

775,501. CONTROLLER; Ernest Schattner, Schenectady, N. Y. App. filed May 13, 1904. A motor starting rheostat having a resistance which decreases in ohmic value when heated, means for closing circuit therethrough, a movable arm, and means whereby said arm, when moved, short circuits the resistance.

775,521. TELEPHONE SYSTEM; George M. Crockett, New York, N. Y. App. filed June 19, 1903.

775,529. ELECTRICALLY OPERATED RAILWAY TRACK SWITCH; Geo. H. Fretts, Springfield, Mass. App. filed Jan. 20, 1904. A switch in the trolley wire is automatically actuated at the same time that a switch in the rail is operated.

775,531. TROLLEY POLE; Willis E. Harmon, Mechanic Falls, Me. App.



774,758.—Electric Spark Gap.

filed Feb. 9, 1904. The trolley pole is in two sections, hinged and provided with a detent which permits it to fold up when it leaves the wire and rises above it.

775,535. SYSTEM OF ALTERNATING-CURRENT DISTRIBUTION; Adolf Emil Waldemar Meissner, Charlottenburg, Germany. App. filed June 16, 1899.

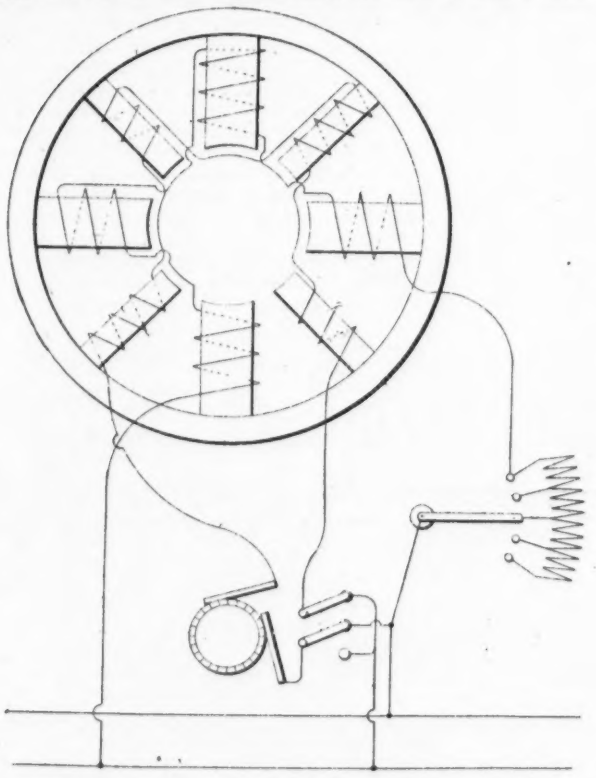
775,560. OSCILLATING MOTOR; Theodore M. Foote, New York, N. Y. App. filed May 17, 1904. The motor has an arc-shaped armature and means for limiting its rotation in the reverse direction.

775,592. INSULATING SUPPORT FOR ELECTRIC THIRD RAILS; Walter H. Barnard, New York, N. Y. App. filed July 28, 1904. The clamp receiving the rail is pivoted upon the insulator, so as to be adjustable.

775,597. PROCESS OF EXTRACTING GOLD FROM ORES; Henry R. Cassel, London, England. App. filed May 22, 1903.

775,654. ELECTRIC FURNACE; Aldus C. Higgins, Worcester, Mass. App. filed April 4, 1904.

775,680. RESONANCE RELAY; Peder O. Pedersen, Copenhagen, Denmark. App. filed July 31, 1901. Vibratory cords stretched between vibratory forks and located in a magnetic field, are used to close a local circuit



775,310.—Variable Speed Motor.

by reason of the mechanical vibrations set up when a current of the same periodicity as the cord and forks is passed through.

775,689. BASE FOR INCANDESCENT LAMPS; Alfred Swan, New York, N. Y. App. filed March 27, 1903. A coupling to be inserted between a lamp base of ordinary style and a lamp bulb of large size, affording a firm support for the bulb and good connection with the base.

775,692. ELECTROMAGNET CIRCUIT CONTROLLER; Eugene W. Vogel and Charles H. Morrison, Chicago, Ill. App. filed March 21, 1902. Details.

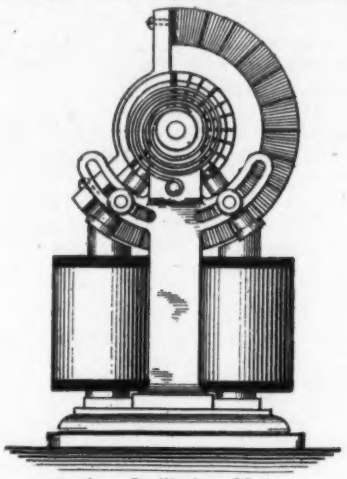
775,714. ELECTRIC HEATER; Edward Paul Weggen, Jefferson City, Mo. App. filed April 22, 1904.

775,723. ELECTRIC BURGLAR ALARM; Amos Getto, New York, N. Y. App. filed April 27, 1904. A circuit-closing plate and bell to be attached to the door knob.

775,736. ELECTRIC SIGNALING SYSTEM FOR RAILWAYS; Emilio Sera and Floriano Stolfi, New York, N. Y. App. filed July 18, 1904. Details.

775,752. MANUFACTURE OF BARIUM HYDRATE; Frederik Jahn, Ridley Park, Pa. App. filed Sept. 5, 1903.

775,768. APPARATUS FOR OPERATING ARMORED HATCHES, TRAP-DOORS OR THE LIKE; William B. Cowles, Cleveland, Ohio. App. filed July 25, 1904. A cut-out is used for automatically opening the motor circuit in case the hatch or door opposes unusual resistance to its closure.



775,560.—Oscillating Motor.

775,777. TROLLEY; Edward L. Naret and Joseph R. Ernst, Morgantown, W. Va. App. filed Sept. 16, 1904. Details.

775,779. ROSETTE FOR SUSPENDING OR SUPPORTING INCANDESCENT LAMPS; Harry E. Rossiter, Sunbury, Pa. App. filed June 2, 1904. Details.

775,797. RAILWAY SIGNALING APPARATUS; John T. Cade, Midland Township, N. J. App. filed Oct. 6, 1902. An actuating part is provided which receives motion from a motive mechanism under the control of a single clutch and which produces a clear indication in one part of its movement and another clear indication in another part of its movement.

775,808. TROLLEY; Joseph B. Elker and James F. Tobin, Pittsburg, Pa. App. filed Jan. 26, 1904. Details.

775,812. INSULATOR SUPPORT; Ernest H. Fairbanks, Philadelphia, Pa. App. filed Sept. 8, 1904. A metal strap carrying teeth adapted to be engaged by a screw thread and bent over upon itself to form a spring; the insulator is passed over it and screwed into place.

775,834. ELECTROMAGNETIC BRAKE; Robert C. Lowry, New Westminster, Canada. App. filed April 13, 1903. An arm pivoted in the middle and carrying a brake shoe at each end is drawn into frictional engagement with the rims of two wheels when said wheels are magnetized.

775,835. ELECTROMAGNETIC BRAKE; Robert C. Lowry, New Westminster, Canada. App. filed Aug. 13, 1903. A modification of the preceding invention.

775,836. TRACTION INCREASING DEVICE; Robert C. Lowry, New Westminster, Canada. App. filed Aug. 13, 1903. Details of construction for magnetizing car wheels.

775,837. TRACTION INCREASING DEVICE; Robert C. Lowry, New Westminister, Canada. App. filed Aug. 13, 1903. A yoke embracing at each end the wheel axle and wound with a magnetizing coil.

775,846. WIRELESS TELEGRAPH; Roberto L. De Moura, New York, N. Y. App. filed Jan. 16, 1902. A local telephonic circuit gives out a continuous sound which is modified to produce signals by the impulses received from the distant station.

775,847. TROLLEY WHEEL; Miles L. Mowry, Greenfield, Mass. App. filed March 14, 1904. The wheel has a hard-metal tread.

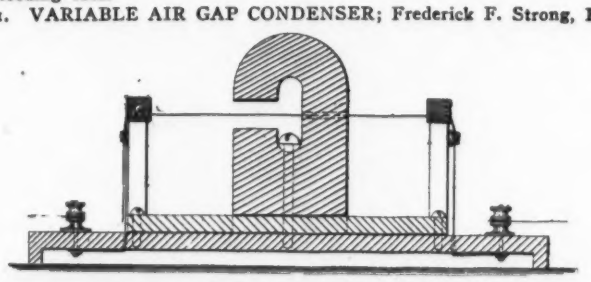
775,857. DYNAMO ELECTRIC MACHINERY; Henry G. Reist, Schenectady, N. Y. App. filed May 18, 1903. The machine is mounted with its axis eccentric to the driving shaft, whereby the distance between the shaft can be varied and the angular relation between the field of the machine and its armature can be altered by rotating the support of the machine.

775,867. TROLLEY; William S. Stockton, Philadelphia, Pa. App. filed Aug. 18, 1904. Details.

775,869. PORTABLE HIGH FREQUENCY APPARATUS; Frederick F. Strong, Boston, Mass. App. filed May 23, 1904. A compact simple outfit adapted to the practical requirements of the ordinary physician.

775,870. PORTABLE HIGH FREQUENCY APPARATUS; Frederick F. Strong, Boston, Mass. App. filed May 23, 1904. A modification of the preceding idea.

775,871. VARIABLE AIR GAP CONDENSER; Frederick F. Strong, Boston,



775,680.—Resonance Relay.

Mass. App. filed May 23, 1904. Opposite electrodes each having continuous discharge edges for transmitting a convective spray discharge across the intervening air gap.

775,872. ROTARY SPARK GAP; Frederick F. Strong, Boston, Mass. App. filed May 23, 1904. A low resistance arc is provided to operate in connection with the electrodes for drawing away and dissipating the heat from the latter.

775,891. APPARATUS FOR GENERATING ELECTRIC CURRENTS; Charles S. Bradley, Avon, N. Y. App. filed Sept. 11, 1897. (See Current News and Notes.)

775,892. GALVANIC ELEMENT OR BATTERY; Paul Brandt, Schoneberg, near Berlin, Germany. App. filed April 20, 1904.

12,286. PLURAL LAMP SOCKET; Reuben B. Benjamin, Chicago, Ill. App. filed Aug. 25. 1904. A reissue of patent 759,963.

MAGNET WIRE CO.

OFFICES
42 BROADWAY
NEW YORK

FACTORIES
NEW YORK AND
ANSONIA, CONN.

MAGNET
WEATHERPROOF AND TROLLEY WIRE

ATLANTIC INSULATED WIRE & CABLE CO.

WIRES AND CABLES,

FOR SUBMARINE, AERIAL, UNDERGROUND AND INTERIOR USE.

FACTORY,
STAMFORD,
CONN.

120 LIBERTY STREET,
NEW YORK CITY.

PATENTS

Law Offices
OF
DYER & DYER
31 Nassau Street
NEW YORK CITY

Patent Soliciting and Litigation
Electrical Cases a Specialty

FOR CARD INDEX
ELECTRICAL WORLD AND ENGINEER, NOV. 26, 1904

Measuring Instrument Patent Decision	890
Boston Rapid Transit Commission	890
The Chicago Freight Subway	890
Electric Power Along the Niagara Frontier	891
Traction Systems of Paris. By Paul Dubois	893
The Induction Motor with High Resistance Secondary. By C. J. Spencer	898
Transformers in Series for High-Tensions	898
Lightning Rods, Wireless Telegraphy and the Dispersion of Fogs by Electricity. By A. Frederick Collins	899
Notes on the Cost of Power in a Railway Plant. By H. S. Knowlton	900
The Winter-Eichberg Single-Phase Railway Motor	901
Another Electric Road for New York	904
The Air in Electric Subways	904
Improving Elevated Electric Traction in New York	905
Heavy Electric Traction in England	905
Dimensions of Bus Bars. By Max Freimark	906
Digest of Current Electrical Literature	907
Alternating Current Traction from Gas Power	910
Christmas Tree Lamp Socket	911
Storage Batteries for Stationary and Vehicle Work	911
Single-Phase Self-Starting Induction Condenser Motors	912
The Cost of Lighting Cigars by Electricity	912
Mechanical Speed Control	913
Small Direct-Current Motor	913

Wm. A. Rosenbaum Wm. M. Stockbridge
ROSENBAUM & STOCKBRIDGE
Patent Attorneys
140 Nassau St., - - New York City

HENRY C. TOWNSEND
Formerly Principal Examiner Electrical Division U. S. Patent Office.
DELBERT H. DECKER
Late Assistant Examiner Electrical Division U. S. Patent Office.
TOWNSEND & DECKER Solicitors of U. S. and Foreign Patents
141 Broadway, New York
Expert Opinions on the scope and validity of Patents

GOEPEL & NILES
COUNSELORS AT LAW
REGISTERED PATENT ATTORNEYS
U. S. and Foreign Patent Trade Marks, Copyrights
290 Broadway, Dun Bldg., New York.

A. J. RUEL
ELECTRICAL MACHINERY
Bought and Sold
NORTH ADAMS, MASS.

DESIGNERS
Invited to write for book "Lava for Mechanical and Electrical Purposes," by P. J. Kruesi, A. A. I. E. E.,
AMERICAN LAVA CO., Chattanooga, Tenn.

W. F. WEISS
CERTIFIED PUBLIC ACCOUNTANT
Tel., 6063 Cortlandt. 128 Broadway, N.Y.
Special and periodical audits, Investigations of Financial conditions, Examinations and reports on Accounts and Earnings, Reorganizations, Consolidations and Partnership adjustments, Introduction of Efficient methods of accounting adapted to special conditions.

EUGENE A. BYRNES, Ph. D., Late Principal Examiner, Division of Metallurgy, U. S. Patent Office.
CLINTON PAUL TOWNSEND, B. S., Late Examiner Electro-Chemistry, U. S. Patent Office.
BYRNES & TOWNSEND
Patent Lawyers
Experts in Electricity, Metallurgy, Chemistry, Electro-Chemistry.
National Union Building, 918 F Street.
Rooms 58, 59, 60, 61. Washington, D. C.

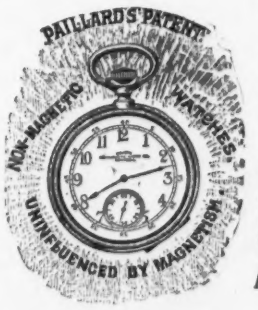
"AMERICAN"
STORAGE CELLS Are the Best
Send for Descriptive Circular
AMERICAN BATTERY CO.
172 So. Clinton St. Chicago, Ill.
Established 1889

INSULATING VARNISHES
Thoroughly Tested
MACON-EVANS VARNISH CO., PITTSBURGH

Electrical Testing Laboratories
Electrical and Photometrical Standardization.
Resistance, Conductivity and Insulation Tests.
Calibration of Measuring Instruments.
Arc and Incandescent Lamp Tests.
Special Investigations.
Secondary Standards of Candle-power Furnished.
546 East 80th Street, New York City

'Tis well known that the presence of acid and metallic impurities used in batteries is very disadvantageous and shortens the life of the batteries.
SAL AMMONIAC
(ELECTRIC BRAND)
is an important factor in improving the results obtained in telephone and small electric batteries. IT IS ABSOLUTELY FREE FROM ALL IMPURITIES AND LENGTHENS THE LIFE OF YOUR BATTERIES.
FOR INFORMATION, ADDRESS
A. KLIPSTEIN & COMPANY,
122 PEARL ST., NEW YORK. (3)

GENUINE HARD
PORCELAIN
EMPIRE CHINA WORKS
144 TO 156 GREEN STREET,
(GREENPOINT) BROOKLYN, N. Y.
FOR ELECTRICAL SPECIALTIES



Magnetism will Ruin your Watch
In this age of electrical wonders it is best when purchasing a watch, to get one not affected by this ever-present and powerful element.
THE PAILLARD NON-MAGNETIC WATCH
is the only watch that cannot be ruined by electrical and magnetic influence. It is absolutely magnetic proof. For descriptive circular write
A. C. BECKEN, 156 Wabash Ave., Chicago, Ill.
Correspondence Solicited.

Export Business is Paying Business.
The Export Issues of ELECTRICAL WORLD AND ENGINEER (first issue of each month), will bring you export business.

POSITIONS WANTED.

The rate for "Position Wanted" advertisements of forty words or less is one dollar each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

POSITION WANTED.—As designing engineer with manufacturing company; university graduate; two years in General Electric Company's Testing Department, and experienced in central station design; thorough practical and theoretical knowledge of A. C. machinery, especially of induction motor and single phase motor design; have important patents on self-starting single-phase motors; position only with reliable firm with good business conditions desired. Address No. 1756, care Electrical World and Engineer, New York.

POSITION WANTED.—After January 1, 1905, as superintending and supervising electrician; twenty years' of practical experience with electric light and power plants; fifteen years with present employers; age 39 years; married; best of references both as to character and ability. Address No. 1747, care Electrical World and Engineer, New York.

POSITION WANTED.—With firm of electrical engineers or contractors, or manufacturers of motors or electrical apparatus; technical education; experienced in contracting, motors, electrical supplies, etc.; age 28; good salesman and solicitor; small salary to start or commission. Address No. 1752, care Electrical World and Engineer, New York.

POSITION WANTED.—An English gentleman, for a number of years Works Manager of one of the largest English electric cable works, desires an opening in the same line in the United States; genuine and confidential; further particulars will be given on application to No. 55, care McGraw Publishing Co., Hastings House, Norfolk St., Strand, W. C., London, England.

POSITION WANTED.—By electrical engineer, experienced in designing, estimating on and installing electrical equipments, both direct and alternating current, with high tension work a specialty, as superintendent, manager or buyer. Located at present on Pacific Coast. Address E. L. Derborn, 1631 Post Street, San Francisco, Cal.

YOU NEED IT!

GALES COMMUTATOR COMPOUND.

Gale's Commutator Compound

The only Article that will Prevent Sparking

Will keep the commutator in good condition and prevent cutting. Absolutely will not gum the brushes. 50c. per stick. $5.00 per dozen. *Send 50c. for trial stick.*

FOR SALE BY ALL SUPPLY HOUSES, OR (1)

K. McLENNAN & CO. SOLE MANUFACTURERS Room 411, 130 Dearborn St., CHICAGO

IF YOU WANT AN ARTICLE THAT WILL REPEAT ITSELF.

TRY U.S.METAL POLISH

FOR POLISHING ALL KINDS OF METALS.

Sold by Dealers. Sample Free.

Geo. W. Hoffman, MANUFACTURER. 215 E. Washington St., Indianapolis, Ind.

CRESCENT SOLDERING PASTE

No Corrosion
Quick Action
A Perfect Joint

Specify

Crescent

and the above is assured. For sale by all supply houses.

Manufactured by

Crescent Company

CHICAGO

New York Office, 203 Broadway

POSITION WANTED.—By technically educated young man with four years' comprehensive experience in large lighting and railway company, desires responsibility for electrical end of moderate sized plant; can handle men and obtain maximum efficiency possible with present apparatus. Moderate salary. Address No. 1759, care Electrical World and Engineer, New York.

POSITION WANTED.—By A1 armature winder; wish to correspond with parties who want an expert all-around man; railway work a specialty; steady, sober and industrious. Address No. 1758, care Electrical World and Engineer, New York.

POSITION WANTED.—By a man of experience in the Brush Electric Company's factory and 17 years in central stations, 10 years in last station as superintendent and manager; a thorough mechanic and can give references; will be at liberty Dec. 15, 1904. W. S. Newman, Lambertville, N. Y.

POSITION WANTED.—By electrical and mechanical engineer with electric or manufacturing plant or railroad company; seven years' experience in laying out and erecting light and power plants and electric railroads; A1 references. Address No. 1762, care Electrical World and Engineer, New York.

HELP WANTED.

The rate for "Help Wanted" advertisements of forty words or less is one dollar and fifty cents an insertion; additional words three cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

WANTED.—Young man to sell insulating material; preference given to one who has had practical experience in armature and field coil insulation in electrical manufactory or large electric railway repair shop; state age, experience and salary required. Address No. 1745, care Electrical World and Engineer, New York.

WANTED.—Supply salesman to travel in New England, one accustomed to that trade preferred; give age, experience and salary expected. Address No. 1755, care Electrical World and Engineer, New York.

(*Continued on page 86*)

FOR SALE

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed and every machine listed actually in stock at our warehouses.

ALTERNATORS—60 CYCLES

	Lt.	
1	300	Westinghouse, 15-K.W.
1	500	Wood, 25-K.W.
2	900	West., 45-K.W., 2 phase.
1	1200	Westinghouse, 60-K.W.
1	1500	Warren-Medberry, 75-K.W.
2	1500	Westinghouse, 75-K.W.
1	1500	Westinghouse, 75-K.W., 2 ph. d. c. to 14x14 Gates 4-valve aut. engine.
1	1500	Westinghouse, 75-K.W., 2-phase, belted.
1	1800	Gen. Elec., 90-K.W.
1	2400	Gen. Elec., 120-K.W., 3 ph.
2	3000	Warren, 150-K.W.
1	3000	Westinghouse, 150-K.W.
1	3000	Gen. Elec., 150-K.W., 3-phase.
1	3600	Stanley, 180-K.W., 2-phase.
1	7200	Gen. Elec., 360-K.W., 3 ph.

ALTERNATORS—125-133 CYCLES.

	Lt.	
1	350	T.-H. A. 18.
1	650	Wood, 33-K.W.
1	1000	Wood, 50-K.W.
1	1200	Gen. Elec., 60-K.W.
1	2400	Gen. Elec., 120-K.W., A. 120.
2	2400	Gen. Elec., 120-K.W., A.S.120.
1	2400	Westinghouse, 120 K.W.
2	3000	Stanley inductor, 150-K.W.
1	4000	Westinghouse, 240-K.W.

125 VOLT DYNAMOS.

	Lt.	
1	40	Roth, M. P., direct connected to Drake engine.
1	50	Northern, Multipolar.
1	50	Browning, Multipolar.
1	75	Phoenix, direct connected to Case engine.
1	80	Card, Multipolar.
1	100	Triumph, Multipolar.
2	110	Commercial, Multipolar.
1	150	Eddy, Multipolar.
1	165	Am. Engine Co., Multipolar.
1	175	Eddy, Multipolar.
2	210	Edison.
1	210	Phoenix, Multipolar.
1	210	Eddy, Multipolar.
1	250	Lincoln, M.P.
1	260	Commercial, Multipolar.
2	350	Edison, 20-K.W.
2	350	C. & C., Multipolar.
1	350	Card, Multipolar.
1	400	Northern, Multipolar.
2	400	Westinghouse, Multipolar.
2	450	Commercial, Multipolar.
1	450	Quaker City, Multipolar.
1	450	Bullock, Multipolar.
3	450	Sprague-Lundell, Multipolar.
2	450	Eddy, Multipolar.
3	450	Gen. Electric, Multipolar.
1	450	Western Elec., Multipolar.
2	540	Edison, 30-K.W.
1	540	Akron, Multipolar.
1	540	C. & C., 30-K.W., Multipolar.
1	540	Elwell-Parker, Multipolar.
2	540	Gen. Elec., Multipolar.
3	600	Card, Multipolar.
1	650	Milwaukee, Multipolar.
1	650	Westinghouse, Multipolar.
1	650	Churchward, Multipolar.
1	650	Gen. Electric, Multipolar.
1	650	Westinghouse, Multipolar, 35-K.W., engine type, direct connected to 10x10 enclosed self-oiling Buffalo Forge engine.
2	700	Commercial, Multipolar.
1	700	Crocker-Wheeler, Multipolar.
2	800	Gen. Elec., Multipolar.
1	900	Wagner, Multipolar, comp.
1	1000	Edison, 60-K.W.
1	1000	Gen. Elec., 6 pole, comp., direct connected to 12x13 Weston automatic engine, 60-K.W.
1	1100	Triumph, Multipolar.
1	1300	Card, Multipolar.
2	1300	Gen. Elec., M.P., 65-K.W.
1	1350	Fort Wayne, comp., direct connected to 13x14 Buckeye vertical engine, 80-K.W.
2	1350	Gen. Elec., Multipolar, 6 pole shunt, direct connected to Ames tandem comp., 11x17x12 automatic engine.
2	1500	Gen. Elec., M.P., 85-K.W.
2	1800	Edison, 100-K.W.
1	1800	Western Electric, Multipolar, comp., 6 pole, 100-K.W.
2	2500	Western Electric, Multipolar, comp., 150-K.W., direct connected to 16x18 McEwen engine.

220 TO 250 VOLT COMPOUND GENERATORS.

	K.W.	
1	7½	Holtzer-Cabot.
1	9	New England, Multipolar.
1	12	Crocker-Wheeler, M.P.
1	12	Milwaukee, Multipolar.
1	12	Sprague-Lundell, M.P.
1	17½	Eddy.
1	25	Gen. Elec., Multipolar.
2	35	Bernard, M.P.
1	40	E. & C., Multipolar.
1	50	C. & C.
1	45	Edison.
2	45	Am. Engine Co., Multipolar.
1	45	C. & C., Multipolar.
1	50	Commercial, Multipolar.
1	50	Maine, Multipolar.
1	55	Fuller, Multipolar.
1	70	Western Electric.
1	75	Siemens & Halske, Churchward type, Multipolar, for direct connection.
1	80	C. & C.
1	100	Commercial, Multipolar.
1	125	Eddy, Multipolar.
2	150	National, Multipolar.
1	200	Eddy, Multipolar.
1	200	Westinghouse, Multipolar.
1	300	Western Elec., Multipolar.

IMMEDIATE DELIVERY

Westinghouse and General Electric Apparatus

DIRECT-CONNECTED ALTERNATING CURRENT GENERATORS.

25 CYCLE, 3 PHASE.

1—1800-K.W. General Electric, 3 phase, 25 cycle, 13,200 volt, 79 amp., type A. T. B. 32-1800-94 R. P. M. Direct connected to a 32 and 64 x 48 C. and G. cooper, heavy duty, cross compound, Corliss Engine. Designed for 200 lbs. steam pressure. Shaft 23 in. diameter in bearing, 27 in. diameter in the field. There is with this unit a 50-K.W., 125 volt, General Electric, 6 pole type, exciter direct-connected to a General Electric marine type vertical engine. Also a 50-K.W. General Electric motor driven exciter set, the motor being a direct-connected, Form K, three phase, 25 cycle, complete with transformer. Also a General Electric machine panel, complete with instruments, a panel for the motor driven exciter with necessary instruments, a panel for the direct-connected engine type exciter with necessary instruments, and one feeder panel for use in connection with the steam driven exciter. There is also a large stock of spare parts for the engine.

1—1500-K.W., fly-wheel type, 3 phase, 25 cycle, 11,000 volt alternator, direct connected to Cross Compound heavy duty horizontal Corliss engine, with cylinders 32 and 64 x 54. Speed 94 R. P. M.

1—500-K.W. General Electric, type A. T. B., 440 volts, 3 phase, 25 cycle. 100 R. P. M., vertical split field and armature type generator for direct connection to gas engine, or steam engine, revolving field type. Convertible to any standard voltage.

DIRECT-CONNECTED ALTERNATING CURRENT GENERATORS.

60 CYCLE, 2 AND 3 PHASE.

1—600-K.W. General Electric, 3 phase, 60 cycle, 605 volt, type A. T. B., 80-600-90 R. P. M., direct-connected to 32 x 48 Allis simple horisontal Corliss engine, 90 R. P. M.

2—500-K.W. Stanley, type 2 P., 2400 volt, 2 phase, 60 cycle, 100 R. P. M., direct-connected to a 20 and 38 x 42 horisontal cross compound heavy duty engine.

1—150-K.W. Westinghouse, 2200 volt, 2 phase, 60 cycle, 257 R. P. M., engine type generator, direct-connected to 1-12 and 24 x 14 Harrisburg horizontal, tandem compound engine.

3—125-K.W. Westinghouse, 60 cycle, 1100 or 2200 volt, 2 phase alternators for direct-connection. Speed, 250 R. P. M. We offer these with vertical Westinghouse compound engines, with cylinders 16 and 27 x 16 in., or other engines could be furnished if necessary.

Write for latest catalogue, just out, of Electrical and Steam Machinery giving large list of other alternating and direct current Motors and Generators, Engines and Boilers.

GET OUR ESTIMATE ON COMPLETE POWER PLANT WORK

ROSSITER, MacGOVERN & CO.

17 BATTERY PLACE, NEW YORK BRANCH OFFICES: 84 State St., Boston. Compton Ave., St. Louis

MODERN ELECTRIC MACHINERY FOR SALE

Alternating Induction Motors

3 Phase 60 Cycles	2 Phase 60 Cycles	220 Volts D. C. Dynamos or Motors	110 Volts D. C. Dynamos or Motor
30-H.P. Gen. Elec., 220 V.	30-H.P. Westinghouse, 220 or 440 V.	55-K.W. Gen. Elec., M. P.	45-K.W. Edison.
10-H.P. Gen. Elec., 110 V.	20-H.P. Westinghouse, 220 or 440 V.	20-H.P. Card.	15-K.W. Eddy, M. P.
5-H.P. Gen. Elec., 220 V	15-H.P. Westinghouse, 220 or 440 V.	15-H.P. Sprague, M. P.	10-H.P. Storey.
5-H.P. Gen. Elec., 110 V.	10-H.P. Westinghouse, 220 or 440 V.	15-H.P. Gen. Electric Type C. E.	7½-H.P. Gen. Elec., C. E. type.
3-H.P. Westinghouse, 110 or 220 V.	7½-H.P. Westinghouse, 220 or 440 V.	10-H.P. Gen. Elec., M. P.	5-H.P., 4-H.P. Eddy.
2-H.P. Gen. Elec., 110 or 220 V.	5-H.P. Stanley, 220 V.	7½-H.P. Crocker-Wheeler, M. P.	3-H.P., 1-H.P. C. & C.
½-H.P. Gen. Elec., 220 or 110 V.	2-H.P. Westinghouse, 220 v.	5-H.P. C & C.	2-K.W. Westinghouse, M. P
		3-H.P. Sprague.	1-H.P., ½-H.P. Eddy.

Buy, Rent and Install **George Bender, 137 Center St., N. Y.**

An Intending Purchaser

of Electrical Apparatus anywhere always consults this paper's advertising pages to ascertain who makes what he wants. ELECTRICAL WORLD AND ENGINEER is recognized in every country of the world as the leading electrical journal

BARGAINS

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed and actually in stock.

ARC DYNAMOS.

Lt.	C.P.	
1	45	1200 Brush.
1	45	1200 T.-H., M 12.
1	50	1200 T.-H., L D 12, new arm.
2	50	2000 T.-H., M D 2. s-o, ring.
2	80	2000 Excelsior.
1	125	1200 Excelsior.
1	150	1200 Brush, Multi-circuit.

220 VOLT MOTORS.

H.P.	DIRECT CURRENT.
1	1 Browning.
1	2 Milwaukee, M.P.
1	2 Bernard, M.P.
1	3 Gibbs, Multipolar.
1	3 Browning, M.P.
2	3 Westinghouse, Multipolar.
1	4 Commercial, Multipolar.
1	5 Gibbs, Multipolar.
1	5 General Electric.
1	5 Hobart.
2	5 Western Electric.
1	5 Eddy, Multipolar.
2	5 Crocker-Wheeler special printing press motors, direct con.
1	6 Westinghouse, M.P.
2	7½ Western Electric, Multipolar.
1	7½ Milwaukee, Multipolar, series.
1	8 Holtzer-Cabot.
1	8 Crocker-Wheeler, series.
1	10 Standard, Multipolar.
1	15 Crocker-Wheeler, M.P.
1	10 C. & C., Multipolar.
1	15 Milwaukee, M.P.
1	10 Keystone, Multipolar.
1	15 Sprague-Lundell, M.P.
1	15 Keystone, Multipolar.
1	15 New England, Multipolar.
1	20 Eddy.
1	20 Kester.
2	25 Edison.
1	30 Gen. Electric, M.P.
1	25 Keystone, Multipolar.

H.P.		
1	25	Eddy, Multipolar.
3	35	Western Electric, Multipolar.
1	60	C. & C., Multipolar.
2	50	Am. Engine Co., Multipolar.
1	60	C. & C.
1	60	Edison.
1	55	Gen. Electric, M.P.
1	60	Commercial, Multipolar.
1	60	C. & C., Multipolar.
1	60	Maine, Multipolar.
1	70	Fuller, Multipolar.
1	85	Western Electric.
1	100	C. & C.
1	125	Edison.
1	135	Commercial, Multipolar.
1	150	Commercial, Multipolar.
1	150	Eddy, Multipolar.
2	200	National, Multipolar.

500 VOLT MOTORS.

H.P.		
1	1	Lundell.
2	1	General Electric.
1	1	Holtzer-Cabot.
2	1½	Northern, series.
1	1½	Crocker-Wheeler.
1	2	Browning.
1	2½	New England.
1	3	C. & C.
1	3	Browning.
1	3	General Electric.
1	3	Jenney, Multipolar.
1	3½	Westinghouse, Multipolar.
1	4	Maine, M.P.
1	4	Bernard, Multipolar.
1	5	Fort Wayne.
1	5	Card.
1	5	C. & C.
1	7½	Card, Multipolar.
1	7½	Northern, Multipolar.
1	7½	C. & C., Multipolar.
2	7½	Crocker-Wheeler.
1	7½	Eddy, Multipolar.
1	10	Milwaukee, Multipolar.
1	10	Crocker-Wheeler.
1	10	Eddy, Multipolar.
2	10	Belknap, Multipolar.
1	12	Am. Engine Co., Multipolar.
1	15	General Electric, M.P.
1	15	C. & C.
1	15	Edison.
1	15	Perrett, Multipolar.
1	20	Bernard, Multipolar.
1	20	Sprague-Lundell, M.P.
1	20	Holtzer-Cabot, Multipolar.
1	25	Eddy, Multipolar.
1	35	Card, M.P.
1	45	C. & C., M.P.
1	50	Northern, M.P.

ALTERNATING MOTORS.

SINGLE PHASE. 125-133 CYCLES.

H.P.		
1	¼	General Electric, 104 volts.
1	½	Stanley, 50 volts.
2	¼	Stanley, 110 volts.
1	½	Warner, 110 volts.
1	1	Wagner, 208 volts, automatic.
2	1½	Wagner, 208 volts, automatic.

SINGLE PHASE. 60 CYCLES.

H.P.		
1	¾	General Electric, 110 v.
1	1	Phillips, 220 v.
1	1	Wagner, 220 volts.
1	2	Wagner, 104 volts.
1	3	Wagner, 104 volts.
1	30	Wagner, 104 volts.

TWO PHASE. 60 CYCLES.

H.P.		
1	50	Westinghouse, 400 v.
1	50	Westinghouse, 220 v.

THREE PHASE. 60 CYCLES.

H.P.		
2	1	General Electric, 110 volts.
1	2	General Electric, 110 volts.
1	2	General Electric, 220 volts.
1	3	General Electric, 110 v.
1	7½	Westinghouse, 220 v.
1	10	Gen. Elec. 110 volts.
1	15	Gen. Elec., 110 volts.
1	30	Gen. Elec., 110 volts.
1	50	Westinghouse, 220 volts.
1	50	Westinghouse, 220 volts.

ELECTRIC LOCOMOTIVES.

Tons.	
1	10 Morgan-Gardner, type M, 250 v. direct current, double motor locomotive, 74-K.W., 42-inch gauge, speed 6 to 10 miles per hour.

ARC LAMPS

300 Sterling, 110 volts, direct-current, enclosed. Brand new. Big bargain.

ENGINES (Compound)

One 20 x 36 x 36 Buckeye tandem.
Two 17 x 28 x 18 Harrisburg tandem.
One 16 x 30 x 48 Hamilton Corliss.
One 16 x 28 x 16 Erie Ball cross.
Two 15 x 23 x 17 McIntosh & Seymour.
One 13 x 23 x 17 McIntosh & Seymour.
One 11 x 19 x 24 Buckeye, tangye frame.

ENGINES (Simple)

One 28 x 54 Hamilton Corliss.
One 26 x 48 Land & Bodley Corliss.
Four 24 x 56 Watts Campbell Corliss.
Two 20 x 42 Hamilton Corliss.
One 20 x 27 Russell, four valve.
One 18 x 42 Putnam.
One 17 x 42 Brown cut-off.
Two 18½ x 18 A. L. Ide.
One 18 x 16 Westinghouse.
One 15 x 20 Harrisburg.
Two 15½ x 16 Buckeye.
One 15 x 14 Armington & Sims.
Two 13 x 21 Buckeye, tangye frame.
One 12 x 12 Armington & Sims.
One 11 x 12 New York Safety.
One 10 x 12 New York Safety.

BOILERS

One 540 H. P. Sterling, 160 lbs. pressure.
Two 66" x 16' horizontal tubular, 120 lbs.

Send for latest Bargain List of "Electrical and Steam Machinery"

JOSEPH H. THOMPSON, Jr.,
11 Broadway, New York City

FOR SALE.

DIRECT CONNECTED.

400-Lt. Edison Dynamo, 110 volts to Brotherhood engine.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo, to Brotherhood engine, 80 volts.
20-H.P. Elektron, 220 volt motor to Morse-Williams freight elevator.

BELTED.

15-H.P. Herreshoff engine.
2000-Volt Electro Dynamic arc dynamo. 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-Amp. Westinghouse dynamo, 110 v.
35-Amp. Sprague dynamo, to Hornby-Ackroyd oil engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts with spare armature.
8 Siemens & Halske 5-H.P., 220 volt motors, enclosed waterproof.
2 Searchlights.
8—5-H.P. Cutler-Hammer, 220 volt series wound reversible controllers.
1—2½x4 Laidlaw-Dunn-Gordon plunge power pump.
3 Thomson wattmeters, 450 amp., 125 volts.

Large stock of smaller dynamos and motors.

Repairing of electrical machinery in all its branches.

Write for our list of motors and dynamos or visit our shop, where the above-mentioned machinery can be seen.

JORDAN BROS., 74 Beekman St., N. Y.

---

60 CYCLE ALTERNATORS.

700-K.W. Westinghouse, 3 phase.
180-K.W. General Electric.
150-K.W. Wood, Type W. A. L.
150-K.W. Westinghouse, 3 phase.
120-K.W. Westinghouse, 2 phase.
120-K.W. General Electric, single phase.
100-K.W. General Electric, 3 phase.

133 CYCLE ALTERNATORS.

150-K.W. Wood, three bearing.
120-K.W. General Electric.
75-K.W. Wood.

125 VOLTS DIRECT CURRENT.

100-K.W. Western Electric, direct connected.
100-K.W. General Electric, direct connected.
50-K.W. Eddy, direct connected.

250 VOLTS DIRECT CURRENT.

150-K.W. Bullock, six pole.
100-K.W. General Electric, direct connected.

RAILWAY GENERATORS.

300-K.W. Westinghouse, six pole.
250-K.W. Western Electric, six pole.
200-K.W. Edison Bipolars.

CORLISS ENGINES.

16&30x48 Cooper Compound Corliss.
24x48 Hamilton Corliss.
24x42 Atlas Corliss.
20x42 Hamilton.

AUTOMATIC ENGINES.

18x16 Ball, brand new.

Send for complete list just issued of Engines, Dynamos, Boilers and Station Equipment.

STATION EQUIPMENT COMPANY 204 DEARBORN STREET, CHICAGO.

(*Continued from page 84.*)

WANTED.—Mechanic with full set of tools, who is familiar with all the mechanical work and machines of an up-to-date incandescent lamp factory; one preferred who has executive abilities to act as assistant superintendent; state experience and lowest salary expected. Address No. 1760, care Electrical World and Engineer, New York.

WANTED.—Technical man in every town; no goods to sell; no expense; those appointed so far are professors, members A. I. E. E. and A. S. M. E., literary draftsmen, etc.; no conflict with regular business. Address No. 1761, care Electrical World and Engineer, New York.

WANTED.—Salesman for incandescent lamps. State age, height and weight, whether married or not, electrical experience, whether college graduate; what degree, and territory familiar with. Address No. 1750, care Electrical World and Engineer, New York.

BARGAINS

Alternating and direct current motors. Dynamos at bargain prices. Send in your requirements and we will be pleased to quote you. We buy, rent and install.

EUGENE L. RICHTER
1914 Columbia Ave.
PHILADELPHIA, PA.

FOR SALE

52 double carbon open T.H. arc lamps, 6.8 amp.
6 single carbon open T.H. arc lamps, 6.8 amp.
26 enclosed T.H. arc lamps, used 4 yrs., 6.8 amp.
6 enclosed A.B. arc lamps, latest type, 6.8 amp.
Shades and inner globes for enclosed lamps.
Outer globes for open lamps.
7500 C. C. carbons, 7/16x12".
2500 C. C. carbons, 15/32x12".

The above lamps have just been taken down and replaced with enclosed 5 amp. lamps. The Clinton Mills Power Co.; Cooperstown, N. Y.

FOR SALE.

ARC DYNAMOS.

2—T.-H. M. D. 12 Ring armatures. S. O. Capacity 75 open 1200 C. P. Lts. or 50 enclosed 2000 C. P. Lts.

ALTERNATORS. 125-140 CYCLE.

2—1400 Lt. T.-H.—A. 70—1070 R. P M.
1—2000 Lt. 100-k.w. Wood 1050 R. P. M.
1—6000 Lt. 300 k.w. Wood 467 R. P. M.
With Exciters and Rheostats. All machines have self-oiling bearings.

JOS. E. LOCKWOOD,
808 Union Trust Bldg., Detroit, Mich.

FOR SALE

Two 250--K.W. 10,000 volt G. E., three phase, 60 cycle, revolving field, belted generators with exciters and marble switchboard. Address No. 1739, care Electrical World and Engineer. New York.

FOR SALE OR RENT

Plant fully equipped for the manufacture of electric fans and motors. We invite inspection. Good location. Address No. 1754, care Electrical World and Engineer, N. Y.

DO YOU WANT TO SELL?

Am looking for bargains in lighting plants, towns of 5,000 and up.

GEORGE. H. MORSE
LINCOLN, NEB.

Cooper Corliss Engines, Cooling Towers, etc.

FOR SALE

One 18 in. x 34 in. x 48 in. cross compound girder frame Cooper Corliss engine, with direct-driven condenser. Wheel 20 ft. in diam. by 40 in. face.

One 24 in. x 44 in. x 60 in. cross compound girder frame Cooper Corliss engine, with direct-driven condenser. Wheel 24 ft. in diam. by 58 in. wide.

One Worthington cooling tower of sufficient capacity of the 60 in. Cooper engine above mentioned.

Two Jewell belts for the above engines; one 40 in. wide and the other 51 in. wide, and both about 125 ft. long.

Two adjustable belt tighteners; one for each of the above mentioned belts.

One 600 to 700 K. W. Westinghouse belt-driven alternator; 2,400 volts; 60 cycles; 2 phase; speed 320 revolutions.

One 16 in. x 36 in. Hamilton Corliss girder frame single cylinder engine.

SPECIAL

One Alberger barometric condenser with independent dry air and circulating pumps. Three Alberger cooling towers, and all piping and fittings necessary for a 1500 K. W. engine or turbine unit.

The above equipment which is thoroughly modern and in good condition, is for sale, due to reorganization and enlargement of several power plants. Shipment can be guaranteed by February 1st, 1905.

For special prices and full particulars write

T. C. PERKINS & CO.
ENGINEERS AND CONTRACTORS
14 STATE STREET, HARTFORD, CONN.

C. L. JACKSON
BANKER
226-230 The Bourse, Philadelphia
FURNISHES MONEY

to manufacturing plants in need of improvements and additional working capital. Stock and Bond issues arranged for and financed.

ELECTRIC TRAVELING CRANES

PAWLING & HARNISCHFEGER, Milwaukee

To the Point

For Bargains of Distinctly Better Quality

1—200-K.W. 125 volt, G. E. Generator.
1—60-K.W. 125 volt, G. E. Generator.
1—110-K.W. 125 volt, C & C Generator.

DIRECT CONNECTED.

1—40-K.W. Fort Wayne Wood, 220 volt.
1—50-K.W. Am. Ball, 220 volt.
1—25-K.W. General Electric, 125 volt.

500 VOLT.

2—300-K.W. G. E. Belted.
1—150-K.W. G. E. Belted.
2—375-K.W. West. Direct connected.

PUMPS.

Full Assortment.

ENGINES.

Full Assortment.

WANTED.

All kinds of good, serviceable motors, dynamos, engines.

We have a fine proposition for those desiring to exchange their present equipment for something larger or more improved.

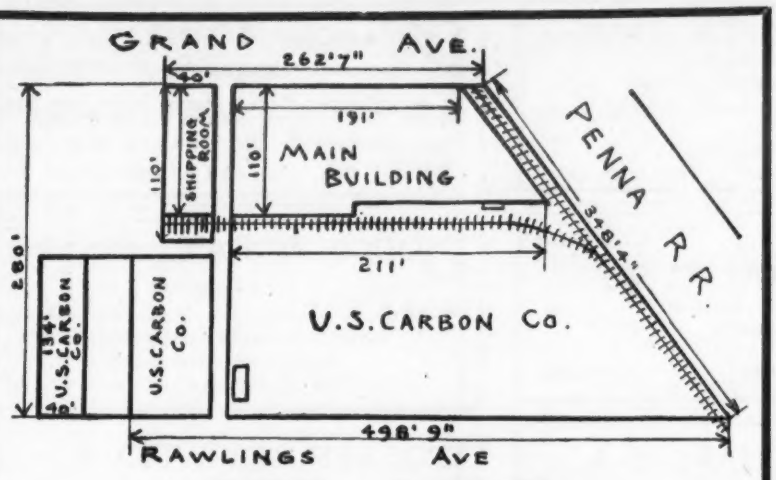
THOMPSON-BONNEY CO.
45 York St., Brooklyn, N. Y.

WANTED

2000-ampere Generator, 10 volt or under, second-hand or new. Address The Monongahela Engineering Co., Pittsburg, Pa.

ELECTRICAL WORLD and ENGINEER

Is more widely quoted abroad than any other electrical journal published



FOR SALE.

PLANT OF THE UNITED STATES CARBON COMPANY, including land, buildings, machinery, etc., situated on the Pennsylvania Railroad within the city limits of Cleveland, Ohio.

LAND—Vacant and covered by buildings about 2½ acres, bounded on two sides by streets and having a frontage of 348 ft., 4 in. on the Pennsylvania Railroad.

BUILDINGS—Main building is a two and one story brick building with gravel roof, the two story part having a frontage of 191 ft. on Grand Ave., by about 50 ft. The one story part having a frontage of 211 ft. on the switch from the Pennsylvania Railroad by about 55 ft. The shipping room is 40 ft. front on Grand Ave., by 110 ft. deep to a switch from the Pennsylvania Railroad and is a two story brick building, with gravel roof; the second floor, however, only covers a space of 14 by 40 ft. in the front part of the building. See diagram of land and buildings above.

MACHINERY—Pulleys, shafting, belting and complete machinery for the manufacture of electric light carbons and for furnishing power, heat and light for the plant. Capacity of plant about 50,000 carbons per day.

For information address

THE GUARDIAN SAVINGS & TRUST CO.

CLEVELAND, OHIO.

WANTED

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Transactions, Vol. 17, bound in cloth

NATIONAL ELECTRIC LIGHT ASSOCIATION

Proceedings of 14th meeting

ADDRESS, NO. 1757, CARE OF ELECTRICAL WORLD AND ENGINEER, NEW YORK

STREET RAILWAY FRANCHISE

SHANGHAI, CHINA.

The Council invites tenders for the construction and operation of about 24 miles of electric tramways on the trolley system in the streets of the Settlement of Shanghai; alternative proposals are desired for single trolley and double trolley lines.

A proforma contract is open to inspection by tenderers, and copies will be supplied to applicants by the Council's Agents:

London: Messrs. John Pook & Co., 63 Leadenhall St.

New York: Messrs. Fearon, Daniel & Co., 96 Wall St.

from whom further information may be obtained. While the conditions stated in the proforma contract are laid down for general guidance the Council desires it to be expressly understood that they are open to such modification as tenderers may consider necessary.

A deposit of £5,000, or certified security to that amount, will be insisted upon, payable at date of signature of contract, and forfeit if the concession is not availed of.

Sealed tenders endorsed "Tender for Tramway Concession" must be sent to the Secretary, Municipal Council, Shanghai, and must be received on or before the 31st March, 1905.

You can increase the efficiency of your advertising by sending us NEW CUTS frequently.

When the Commutator Becomes Worn

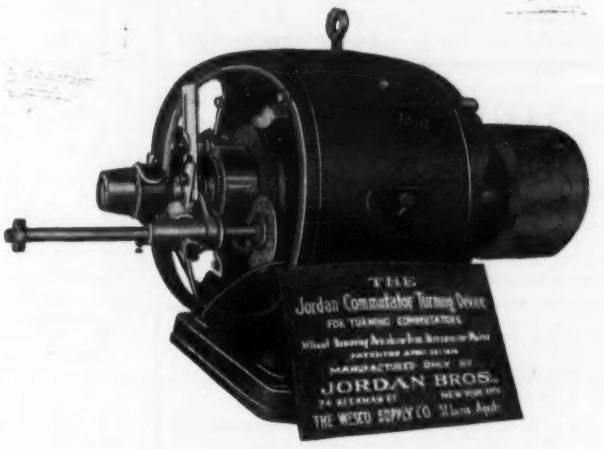
there are two ways of turning it down.

One is to take the armature out of the machine and send it away somewhere to be turned in lathe and lose the use of the machine for a time.

The other way is to put

THE JORDAN COMMUTATOR TRUING DEVICE

on to the machine and true the commutator down as the armature rotates.



It is quick and convenient; it does the work surely and effectively. It saves time and brings the commutator to a true polished surface.

The wheel does not contain emery or any mineral substance that will harm the commutator.

THIS IS THE MACHINE THAT WAS ON EXHIBITION AT THE WORLD'S FAIR

Manufactured only by

JORDAN BROS., 74 Beekman St., New York

TWO NEW BOOKS

AMERICAN METER PRACTICE

By LYMAN C. REED

CONTENTS

CHAPTER I.—Measurement of Direct Current. II.—Measurement of Alternating Current. III.—Requisites of a Good Meter; Commercial Consideration. IV.—Torque and Friction. V.—Edison Chemical Meter. VI.—Thomson Recording Wattmeter. VII.—Duncan Meter, Alternating Current. VIII.—Duncan Meter, Direct Current. IX.—Stanley Meter. X.—Guttman Meter. XI.—Westinghouse Meter. XII.—General Management of Meter Department; Records; Testing—General Policy. XIII.—Reading Meters. XIV.—Relative Value of Losses in Meters to Income. XV.—Differential Rating. XVI.—Elements of Photometry.

Cloth, about 250 pages. Illustrated. Price, $2.00

This is the only American book dealing with the theory and practice of current metering. The author outlines the underlying principles of operation and leaves minor details to be worked out to suit local conditions. Representative types of commercial meters are described. Each meter so described has some distinguishing feature which makes it typical of its class.

Alternating Current Transformers

By F. G. BAUM

CONTENTS

CHAPTER I.—Elementary Principles. II.—Simple Transformer Design. III.—Graphical Representation of Pressure Relations. IV.—Regulation. V.—Efficiency. VI.—Testing. VII.—Systematic Design. VIII.—Circuit Regulators, Constant Current Transformers, Series Transformers, Compensating Voltmeter. IX.—Connections of Transformers for Single-Phase and Polyphase Circuits. X.—Commercial Types of Transformers. American and European Types of Single-Phase and Polyphase Transformers. APPENDIX.—Extracts from Rules and Requirements of the National Board of Fire Underwriters.

Cloth. 195 pages, 122 illustrations. Price, $1.50

The chapters of this book originated from a course of university lectures at Stanford University, Cal., but the material is intended for the use of the engineer and general reader as well as the student. Some knowledge of elementary alternating currents is presupposed. The scope of the work is shown by the table of contents above.

Send for our new 96-page Catalogue of Engineering Books

McGRAW PUBLISHING COMPANY, 114 Liberty Street, New York

ARNOLD ELECTRIC POWER STATION COMPANY
Engineers, Constructors
MARQUETTE BUILDING, CHICAGO.
Designers and Builders of complete Electric Railway, Lighting and Power Installations.
TRANSIT BUILDING, NEW YORK.

BYLLESBY & CO., H. M.
(Incorporated)
Engineers
Design, Construct and Operate Railway, Light, Power and Hydraulic Plants.
Examinations and Reports.
NEW YORK LIFE BUILDING, CHICAGO, ILL.

DOBLE COMPANY, ABNER
Engineers
Complete Hydro-Electric Power Plants and Long-Distance Transmissions designed and constructed.
FREMONT AND HOWARD STS.
Established 1850. SAN FRANCISCO, U. S. A.

W. E. BAKER H. R. BISHOP
BAKER & CO., W. E.
Engineers
37 WILLIAM ST. NEW YORK

C. W. CARMAN. M. C. HARTMAN.
CARMAN & CO., C. W.
Engineers
657 RAILWAY EXCHANGE. CHICAGO.

DODGE & DAY,
Engineers
Power Plant, Foundry and Machine Shop Layout Construction and Equipment.
MOTOR DRIVES A SPECIALTY.
PHILADELPHIA, PENN.

BARSTOW, WILLIAM S.
Consulting Electrical Engineer
56-58 PINE ST., NEW YORK.
Examinations and Reports on Electric Properties. Estimates, Specifications and Plans for Electric Lighting, Power and Railway Plants.
Telephone, 2730 John.

CHAPMAN, CHARLES A.
Consulting Engineer
Rooms 1040-42 204 DEARBORN ST. CHICAGO.

FOSTER, HORATIO A.
Electrical and Mechanical Engineer
Consultation, preliminary reports, specifications and plans for new projects. Investigation of lighting, railway and power properties for investment purposes. Organization and application of accounting systems for central stations, street railways, etc.
650 BULLITT BUILDING, PHILADELPHIA, PA.

PUTNAM A. BATES JOHN NEILSON
BATES AND NEILSON
Consulting Electrical Engineers
42 BROADWAY, NEW YORK.

COLLINS, A. FREDERICK
Wireless Telegraph Engineer
Plans and Specifications; Tests, Measurements and Opinions; Inventions Developed. Experimental Apparatus.
Laboratory, 11 BROADWAY, NEW YORK.

HUMPHREY, HENRY H.
Consulting Engineer
Central Lighting Stations.
Electric Power Transmission
SUITE 1305, CHEMICAL BLDG., ST. LOUIS, MO.

BEEBE AND BENNETT
Engineers and Contractors
Consulting and Contracting Electrical and Mechanical Engineers.
Illumination Experts, Expert Opinions and Reports.
2210 FARMERS' BANK BLDG., PITTSBURG, PA.

CORSON, Wm. R. C.
Consulting Engineer.
Plans, specifications, superintendence of factory, power and lighting installations.
Investigations of electrolysis of underground structures. Electric machine design.
Reports. Laboratory tests and experiments.
36 PEARL ST. HARTFORD, CONN.

IRON CITY ENGINEERING CO.
Contracting Electrical Engineers.
Power and Light Installations.
BELL L. D. TEL. 1599 COURT.
FRICK BLDG., PITTSBURG, PA.

CHAS. L. BROWN, PRESIDENT. STUART H. BROWN, SECY. AND TREAS.
BROWN ELECTRICAL CONSTRUCTION CO.
505 ELLSWORTH BLDG.
355 DEARBORN ST., CHICAGO.
Telephones { Harrison 3698 / Automatic 3698

CORY, C. L. Telephone Main 1870.
MEREDITH, WYNN
ALLEN, W. H.
Engineers,
331 PINE STREET, SAN FRANCISCO.
Expert Examinations. Construction Supervision. Design of Complete Equipments. Betterment of Existing Systems. Engineering and Financial Examinations. Advisory Reports.

JACKSON, DUGALD C., C. E.
JACKSON, WILLIAM B., M. E.
MEMBERS
American Institute of Electrical Engineers
American Society of Mechanical Engineers
American Society of Civil Engineers
Engineers. Experts.
MADISON, WIS.

COPPER COILS CAN'T CORRODE
A permanently plastic coil cement
if treated with **DIELECTROL**
DIELECTRIC MNFG. CO., SAINT LOUIS

CHICAGO EDISON COMPANY
REPAIR SHOPS
76 MARKET STREET, CHICAGO. TELEPHONE MAIN 1280.
FIRST-CLASS EQUIPMENT THROUGHOUT.
OPEN DAY AND NIGHT
DYNAMOS, ARMATURES, MOTORS, ARC LAMPS, INSTRUMENTS; MACHINE AND CARPENTER WORK OF ALL KINDS.
CORRESPONDENCE SOLICITED.

ELECTRICAL WORLD AND ENGINEER
IS MORE WIDELY QUOTED ABROAD THAN ANY OTHER ELECTRICAL JOURNAL PUBLISHED

BOUND VOLUMES
OF THE
Electrical World and Engineer

The ELECTRICAL WORLD began publication as a weekly on January 1, 1883, as the successor of the *Operator*, which had been published since 1874. It has published two volumes per year, of 26 numbers each, from January 1, 1883, to date, the volumes for 1903 being XLI and XLII. On March 4, 1899, the ELECTRICAL WORLD absorbed the *Electrical Engineer*, the consolidated title since appearing as the ELECTRICAL WORLD AND ENGINEER.

COMPLETE SETS

from the beginning are very difficult to obtain, but can occasionally be supplied. Quotations upon request. We can usually supply COMPLETE VOLUMES from January, 1885, to date, at a uniform price of $3.00 per volume, unbound. Binding extra at $1.50 per volume, two volumes per year. Express charges to be paid by the purchaser.

ODD NUMBERS

We have a very large stock of back numbers, as far back as Vol. XXXIII, 1899, and covering with more or less incompleteness, the entire period to 1903. Single numbers prior to 1902, are 25 cents each, unless five or more copies are ordered and paid for at one time, in which case they may be had for 10 cents each. It is our intention to destroy all copies remaining unsold after a limited period, so that you should order such numbers as you need as early as possible.

SEND ORDERS TO THE
ELECTRICAL WORLD AND ENGINEER
114 Liberty Street, New York City

KELLY ENGINEERING CO., THE JOHN F.
Consulting and Contracting Engineers
149 BROADWAY, - - - NEW YORK.
'Phone-7259 Cortlandt.

KOHLER BROTHERS
G. A. EDWARD KOHLER. FRANKLIN W. KOHLER.
Contracting Electrical Engineers
Lighting, Power, Railways.
1804-1806-1808-1810-1812 FISHER BUILDING, CHICAGO.

SAMUEL G. McMEEN. KEMPSTER B. MILLER.
McMEEN & MILLER
1442-3 MONADNOCK BLOCK, CHICAGO.
Telephone Engineers
Estimates, Appraisals, Reports, Plants Constructed.

MASSON, R. S.
Consulting Electrical Engineer,
232 CROCKER BLDG., San Francisco, Cal.
706 LANKERSHIM BLDG. Los Angeles, Cal.

MERSHON, RALPH D.,
Consulting Electrical and Mechanical Engineer
Estimates, Reports, Plans, Specifications and Supervision of Electric Lighting, Railway and Power Plants.
Long Distance Power Transmission.
NEW YORK: 11 PINE ST.
MONTREAL: STREET RAILWAY CHAMBERS.

MURALT & CO.
Engineers and Contractors,
25 PINE STREET, NEW YORK.
Complete Electric Plants. Alternating Current Systems a Specialty.

PALMER, W. K., M. E.,
Consulting Engineer,
718 Dwight Building, Kansas City, Mo.
Home and Bell 'Phones, 3322 Main.
MECHANICAL & ELECTRICAL ENGINEERING.
Electric Railways and Lighting; Power Plants; Manufacturing Establishments; Heating, Ventilating and Refrigerating Systems; Designing of Machinery; Patent Work; Inspections, Tests and Reports.

PEPPER & REGISTER,
General Contractors,
112-116 N. BROAD ST., PHILADELPHIA, PA.
Electric Street Railways a Specialty.

PIERCE, Richardson & Neiler,
Consulting and Designing Engineers
R. H. PIERCE, S. G. NEILER, H. A. ROBINSON
MANHATTAN BUILDING, CHICAGO.
110 STATE STREET, BOSTON.

PRATT & ATKINS,
Engineers
Electrical, Steam, Mechanical.
1000-1001 MONADNOCK BLDG., CHICAGO.

SANDERSON & PORTER
Engineers
Contractors
RAILWAY, LIGHT, POWER & HYDRAULIC DEVELOPMENTS.
52 WILLIAM STREET NEW YORK.

SARGENT & LUNDY,
Engineers,
JACKSON & MICHIGAN BLVDS.
CHICAGO, ILL.
FREDERICK SARGENT. A. D. LUNDY.

SCHOTT, W. H.
Engineer and Contractor
1220-21 MARQUETTE BUILDING, CHICAGO.
SPECIALTIES.—Central Station Heating Plants, Water Works, Steam Plants, Electric Light, Gas and Street Railway Plants.

SHEAFF & JAASTAD,
Mechanical and Electrical Engineers.
Plans and specifications for and superintendence of Electric Power and Lighting Plants a specialty.
85 WATER STREET, BOSTON, MASS.

STANTON, LEROY W.
Consulting Telephone Engineer
Plans, Specifications and Supervision of Installation of complete telephone plants.
Special Reports on Telephone Properties and Apparatus.
411 ELECTRICAL BLDG., CLEVELAND, OHIO

WAGNER, HERBERT A.
Consulting Electrical and Mechanical Engineer
Railway, Lighting & Power Plants.
Specialty, Distribution.
TIMES BLDG., NEW YORK CITY.
415 LOCUST ST., ST. LOUIS.

WALMSLEY, H. B., LL. B.
Legal Specialist in all Mechanical Matters
Collections.
References on application.
ROOM 813, NO. 49 WALL ST., NEW YORK.

WHITE & COMPANY, J. G.,
Engineers, Contractors
43-49 EXCHANGE PLACE, NEW YORK, N. Y.
LONDON CORRESPONDENT:
J. G. White & Company, Limited,
22a College Hill, Cannon St.

THREE BOOKS BY DR. LOUIS BELL

Art of Illumination.
Cloth. 339 Pages. 127 Illustrations. Price, $2.50.

CHAPTER I.—Light and the Eye. II.—Principles of Color. III.—Reflection and Diffusion. IV.—The Materials of Illumination; Illuminants of Combustion. V.—Incandescent Burners. VI.—The Electric Incandescent Lamp. VII.—The Electric Arc Lamp. VIII.—Shades and Reflectors. IX.—Domestic Illumination. X.—Lighting Large Interiors. XI.—Street and Exterior Illumination. XII.—Scenic and Decorative Illumination. XIII.—The Illumination of the Future. XIV.—The Elements of Photometry.

Power Distribution for Electric Railways.
303 Pages, 148 Illustrations. Price, $2.50.

CHAPTER I.—Fundamental Principles. II.—Return Circuit. III.—Direct Feeding Systems. IV.—Special Methods of Distribution. V.—Sub-stations. VI.—Transmission of Power for Sub-stations. VII.—Alternating Motors for Railway Work. VIII.—Interurban and Cross-Country Work. IX.—Fast and Heavy Railway Work.

Electric Power Transmission.
Cloth. 632 Pages, 285 Illustrations, 21 Plates. Price, $3.00.

CHAPTER I.—Elementary Principles. II.—General Conditions of Power Transmissions. III.—Power Transmission by Continuous Currents. IV.—Some Properties of Alternating Currents. V.—Power Transmission by Alternating Currents. VI.—Synchronous and Induction Motors. VII.—Current Reorganizers. VIII.—Engines and Boilers. IX.—Water Wheels. X.—Hydraulic Development. XI.—The Organization of a Power Station. XII.—The Line. XIII.—Line Construction. XIV.—Centres of Distribution. XV.—The Commercial Problem. XVI.—The Measurement of Electrical Energy. XVII.—The Present Status of High-Voltage Transmission.

WE CAN SUPPLY ANY ENGINEERING BOOK. SEND US YOUR INQUIRIES

McGRAW PUBLISHING COMPANY, Publishers, Importers and Booksellers **114 Liberty Street, New York**

W. V.

EIGHT NEW AND IMPORTANT BOOKS

ART OF ILLUMINATION

A treatise dealing with scientific as well as artistic use of modern illuminants.

By LOUIS BELL

Cloth, 389 Pages, 127 Illustrations. Price, $2.50

CONTENTS

CHAPTER I.—Light and the Eye. II.—Principles of Color. III.—Reflection and Diffusion. IV.—The Materials of Illumination; Illuminants of Combustion. V.—Incandescent Burners. VI.—The Electric Incandescent Lamp. VII.—The Electric Arc Lamp. VIII.—Shades and Reflectors. IX.—Domestic Illumination. X.—Lighting Large Interiors. XI.—Street and Exterior Illumination. XII.—Scenic and Decorative Illumination. XIII.—The Illumination of the Future. XIV.—The Elements of Photometry.

JUST PUBLISHED

MAXWELL'S THEORY AND WIRELESS TELEGRAPHY

PART I—Maxwell's Theory and Hertzian Oscillations by H. Poincare, translated by Frederick K. Vreeland. PART II.—The Principles of Wireless Telegraphy by Frederick K. Vreeland.

Cloth, 247 Pages, Fully Illustrated. Price, $2.00

CONTENTS

PART ONE.—CHAPTER I.—Generalizations Regarding Electrical Phenomena. II.—Maxwell's Theory. III.—Electrical Oscillations Before Hertz. IV.—Hertz's Oscillator. V.—Methods of Observation. VI.—Propagation Along a Wire. VII.—Measurement of Wave-length and Multiple Resonance. VIII.—Propagation in Air. IX.—Propagation in Dielectrics. X.—Production of Very Rapid Vibrations. XI.—Imitation of Optical Phenomena. XII.—Synthesis of Light.

PART TWO.—CHAPTER I.—General Principles. II.—Telegraphy by Hertzian Waves. III.—The Grounded Oscillator. IV.—Propagation of Grounded Waves. V.—The Receiving Apparatus. VI.—Selective Signalling. VII.—The Trend of Progress.

THE INDUCTION MOTOR

A book covering the calculation, predetermination, design and general theory of the induction motor.

By B. A. BEHREND

Cloth, 105 Pages, 56 Illustrations. Price, $1.50

CONTENTS

CHAPTER I.—The General Alternating Current Transformer. II. A.—The Character of the Magnetic Field in the Polyphase Motor. II. B.—The Formulæ for the Three-Phase Motor. III.—The Short-Circuit Current and the Leakage Factor. IV.—The Leakage Factor. V.—Design of a Three-Phase-Current Motor for 200 Horse-Power. VI.—The Single-Phase Motor. VII.—Calculation of a Single-Phase Motor. VIII.—The Polar Diagram of the General Alternating-Current Transformer. APPENDICES I, II, III.

SECOND EDITION, CORRECTED

STORAGE BATTERY ENGINEERING

A Practical Treatment for Engineers.

By LAMAR LYNDON

Cloth, 360 Pages, 178 Illustrations and Diagrams, 4 large Folding Plates. Price, $3.00

This is a practical work intended for the electrical engineer who is called on to design and install storage battery equipments, or who has a battery power plant under his care. The first part deals with the storage battery, its construction, action under various conditions, deterioration and the causes of the observed phenomena. The second part covers all the apparatus, devices and methods used in the application and control of batteries.

PRACTICAL TESTING OF DYNAMOS AND MOTORS

By CHARLES F. SMITH

Cloth, 231 Pages, 80 Illustrations. Price, $2.00

CHAPTER I.—General Purpose of Tests. II.—Measurement of Armature and Field Resistances. III.—Production of Electromotive Force in a Dynamo. IV.—The Magnetic Circuit. V.—Armature Reactions. VI.—Shunt-Wound Dynamos. VII.—The Series Dynamo. VIII.—The Compound Dynamo. IX.—Effect of Current in the Motor Armature. X.—Efficiency Tests of a Motor. XI.—Efficiency Test of a Dynamo. XII.—Miscellaneous Tests. XIII.—Motor Generators and Boosters.

STEAM HEATING AND VENTILATION

A scientific treatment of ventilation and steam heating.

By WILLIAM S. MONROE

Cloth, 150 Pages, 90 Illustrations. Price, $2.00

CONTENTS

CHAPTER I.—Introductory. II.—Steam Heating; Systems of Piping and Steam Supply. III.—Steam Heating Apparatus. IV.—Indirect Radiators. V.—Design of Radiation. VI.—Piping and Construction Details. VII.—Mechanical Ventilation—General Principles. VIII.—Systems of Mechanical Ventilation. IX.—Ventilating Ducts. X.—Ventilating Fans, Heaters and other Apparatus.

ELECTRIC MOTORS

A treatise characterized by considerable departures from conventional methods.

By HENRY M. HOBART

Cloth, 450 Pages, 480 Illustrations. Price, $5.00

I—Continuous Current Motors—Introductory—Continuous Current Motors—Data of Motor Designing—Types of Winding—Motor Characteristics—Motor Designing and Testing—Standardization—Examples of Design Form Wound Armature Coils—Comparative Designs for 35-H.P. Motors—Variable Speed Motors.

II.—Alternating Current Motors—Desirability of Polyphase Motors—Methods of Starting Induction Motors—Comparisons Between Induction and Continuous Current Motors.—Design of Induction Motors.—Examples.—Properties of Copper Wire.

STATIC ELECTRICTY

A simple but exact treatise, in which the methods of calculus have been avoided wherever possible.

By HOBART MASON

Cloth, 155 Pages, 63 Illustrations. Price, $2.00

CHAPTER I.—General Phenomena. II.—The Electrostatic Field. III.—Capacity. IV.—Experimental Measurement of Capacity. V.—Instruments Used in Electrostatics. VI.—High Potential Static Generators. APPENDIX.—A.—Dimensions of Units. B.—Ratio of the Units.

Any book in the above list will be sent postpaid on receipt of the price. We can supply any engineering book published.

Send us your inquiries. Catalogues free.

McGRAW PUBLISHING CO.

BOOK DEPARTMENT 114 LIBERTY STREET, NEW YORK